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SOME RECENT DEVELOPMENTS IN RADIOGRAPHY.[1]

BY

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DURING the last few years—since 1907—there has been a rapid displacement of the induction coil by a transformer type of apparatus for radiographic work.

The transformer type of apparatus was developed in order to overcome the greatest objections to the induction coil,—namely, the use of "interrupters," very low electrical efficiency, low time factor of secondary current, and limited secondary output from practical sizes of apparatus. The transformer apparatus has successfully overcome these defects of the "coil" and has introduced no real problems of its own.

The first practical transformer type of Röntgen apparatus was installed in the Jefferson Medical Hospital of Philadelphia in June, 1907, where it still is in daily use. Since that time it has been installed in most of the laboratories of the prominent Röntgenologists and hospitals, both of this country and Europe.

It is manufactured in Europe and this country under various

[1] Presented at the Stated Meeting of the Institute held Wednesday, October 16, 1912.

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names, such as "Interrupterless," "Eresco," "Transverter," "High Potential Rectifier," "Snook Röntgen Apparatus," etc.[2]

This diagram gives the electric circuits and shows the relations of the parts of the Snook apparatus, which in the sizes commonly used in modern hospitals delivers from four to ten kilowatts of electrical energy to the X-ray tube.

The high-tension rectifying switch is maintained in synchronism with the alternating high-tension secondary electromotive force of the high-tension transformer by being attached

FIG. 1.

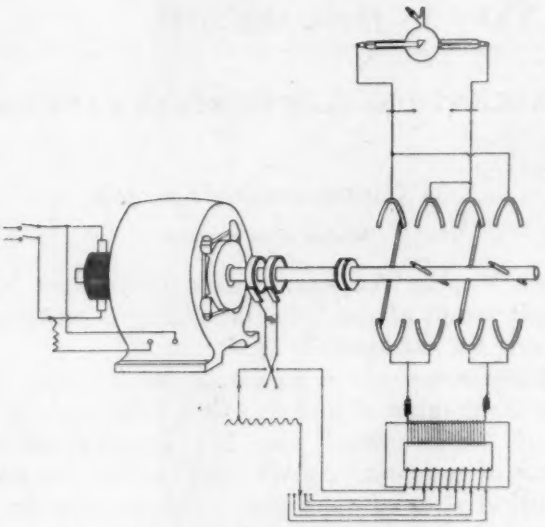


Diagram of Snook Apparatus.

mechanically to the converter generating the low-voltage alternating current, which is fed to the transformer primary.

Both the positive and negative half waves are rectified. Also, a substantial part of each half wave is collected so that the time factor of the current will be much higher than in the case of the secondary current of the induction coil. This general arrangement has enabled the manufacturers to use standard transformer construction and to standardize the apparatus on

[2] See "Die Röntgen Technik," Albers Schönberg, 1908, *Trans. Inst. Röntgen Congress; Archives Röntgen Ray*, 1908.

the basis of a wattage output, instead of a spark length rating. It has removed X-ray machines from the class of laboratory apparatus and placed them in the field of electrical engineering.

Rapid radiography of all parts of the human body has been made a matter of only a few seconds for each exposure by this apparatus, and good radiographs with uniform results from day to day are obtained with it.

It is interesting to note that various types of high potential switches have been used and developed. The balanced rotor of the original type of switch is still to-day the one that has proved to be most efficient, mechanically and electrically. A number of these devices have come out since the first one was developed; but the old type of rotor is the one that has preference to-day. It will be noticed that the rotor is a perfectly-balanced piece of apparatus. That is the idea which really made it finally win out, and it is the one that is used to-day. There have been no great improvements in this apparatus since it was placed on the market. It really remains fundamentally and electrically the same as it did when it appeared in 1907.

With it Dr. Groedel and others have developed a pseudo-bioradiographic apparatus. Some have experimented also with enormous induction coils whereby one impulse is passed through the X-ray tube for each exposure. They have succeeded in attaining a speed of about one radiograph every four or five seconds. By making reductions of these radiographs and placing them on a moving-picture film, and by running the moving-picture film through the projection apparatus, at the rate of about eighteen or twenty a second, they have succeeded in making a pseudo-moving picture of radiographic work.

This apparatus has become of some value in the study and examination of the digestive tract by the use of the "Bismuth meal." And that has led to the development of another type of apparatus, which is called the "Vertical Fluoroscopic Apparatus."

This apparatus makes it possible to examine a patient fluoroscopically in the standing position. When the digestive apparatus, with its meal of bismuth subcarbonate, has reached a stage where a radiograph is desired, a radiograph may be made. It is a highly-developed piece of apparatus. Curtains are provided which protect the operator against the secondary

radiation which emanates from the patient who is within it, although the patient and operator are able to see each other through a lead glass window.

These extreme precautions are taken for the protection of the operators for the reason that X-rays in their effect upon the human body are cumulative. Like some drugs, strychnine for instance, the effect is a cumulative one, and by the repeated giving of small doses the effect is greatly increased until it becomes a dangerous dosage. The danger to the patient is practically nothing, because the patient receives only a slight dosage during his entire lifetime; but with the operator it is different, since he is working with the radiation daily.

The relation between the X-ray tube, the patient, and the operator with respect to the protective features of the apparatus is such that no X-rays can reach the X-ray operator or be detected outside of the apparatus. This is accomplished by an automatic diaphragm, a large lead box in which the X-ray tube is enclosed, and the curtains, just mentioned, which prevent the secondary radiation from the patient of the interior of the apparatus from getting outside it.

There has been developed a modification of the Snook apparatus for the Medical Department of the United States Army. This apparatus derives its power from an ordinary four-cycle air-cooled gas engine. The entire equipment, including all photographic apparatus and the necessary means of supporting the patient on the standard army stretcher while being radiographed, was made so compact that it can be loaded on one standard army wagon drawn by one pair of mules. This apparatus was exhibited by the Medical Department of the United States Army at the last International Congress of the Red Cross Society, which was held in Washington this year.

There was an exhibit of a portable army type of X-ray apparatus made by the French Government at this same Congress, arranged with and built into a large automobile. This apparatus weighed some 8000 pounds, and was awarded the Grand Prize for X-ray apparatus at the Congress.

A development which is really photographic, but which means a great deal to the X-ray operator who has a large number of plates to handle, is the improvement in stand development which has been made by Dr. David R. Bowen and Dr. G. E.

Pfahler, of Philadelphia. Economy of space is an important thing even in the Röntgen laboratory, and the efficient utilization of the cubical contents of the laboratory is a big problem with the growth of cities, the increase in density of population, and the high fixed charges on each foot of floor area.

If the X-ray operator should in one day have to develop thirty or forty plates from the 8-inch-by-10-inch size up to 14-inch-by-17-inch, and were to lay them out on horizontal trays, he would utilize a large floor area with its corresponding cubical contents. Tank development which utilizes the cubical contents of the dark room very efficiently enables the operator to develop, fix, and wash a great many more plates with a fewer number of motions than if the plates are developed in horizontal trays.

Dr. Bowen has developed a plate-holder frame which in combination with proper vertical tanks enables the operator to realize this economy in space in a most practical manner.

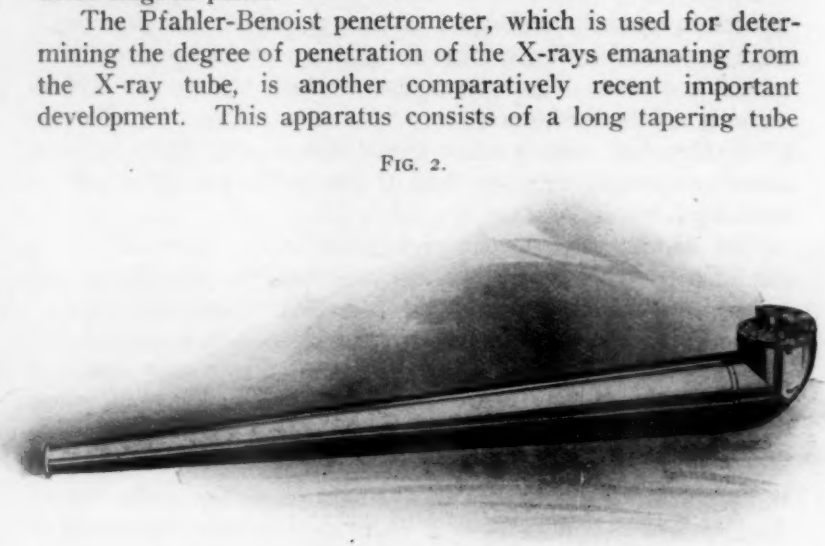
Several water motor types of tray rockers have somewhat displaced the noisy electric ones which up to about a year ago were most popular for the automatic rocking of photographic trays during plate development. These water motor tray rockers, while better than the electric rockers, are useful in helping to solve the problem identified with what might be termed "the retail" development of plates. The stand development, the separate frames for holding each plate—*a la* Dr. Bowen—is the best thing which yet has appeared for what might be termed the "wholesale" development of photographic or X-ray plates.

In photographic plates there has been a real development during the last year. Photographs and amateurs know full well that the rapid plate has a coarse-grained emulsion; that is to say, the general rule is that rapid plates have coarse-grained emulsions. During the last year I have tested at least three makes with fine-grained emulsions that are really quite rapid. These plates are all of English make, and American makers are doing their level best to imitate the results. One interesting thing about these rapid plates is that they have an unusually high percentage of silver. This percentage of silver is about 35 per cent. greater than any of the rest of the X-ray plates. The increased absorption of X-rays by this large percentage of silver in the emulsion is one of the things, of course, that cause

the increased transformation of the X-ray energy into chemical energy and increase the speed of the plate. But there are two types of plates only that have proved very successful with fine-grained emulsions and with a much smaller percentage of silver. I do hope that our manufacturers will find out what to do to give the beautiful surface and the rapid speed of some of these English plates.

The Pfahler-Benoist penetrometer, which is used for determining the degree of penetration of the X-rays emanating from the X-ray tube, is another comparatively recent important development. This apparatus consists of a long tapering tube

FIG. 2.



Pfahler-Benoist Penetrometer.

at the large end of which is mounted the penetrometer proper. The penetrometer itself has in its centre a disk of silver 11/100 millimetre thick, and around it is placed a stairway of aluminum sectors, each step of which is one millimetre thick. Immediately behind this assemblage of sectors and silver disk is a barium platino cyanide screen. Beyond it, at an angle of 45 degrees, is a mirror arranged so that the operator by looking into the large tube can see the fluoroscopic image produced by the aluminum sectors and silver disk.

Dr. Benoist discovered the fundamental fact that 11/100 millimetre of silver offers a fairly constant absorption to Röntgen radiation of all degrees of hardness. The varying steps of aluminum thickness have variable absorption for variable degrees of X-ray penetration. The operator, therefore, simply

by matching the shadow of the silver disk against the shadows of the aluminum sectors, is able to read the hardness factor of the radiation. This is the most accurate method in existence to-day by which to measure the degree of penetration of the radiation emanating from an X-ray tube.

Another important recent development is the improved Sweet eye localizer, which is the work of Dr. Wm. M. Sweet, a celebrated eye surgeon, who for a number of years has used the eye localizer which he has tried to get other people to use, but has been somewhat unsuccessful because of the difficult technique. This new apparatus was developed by Dr. Sweet so that the difficulties of technique could be reduced to mechanical operations.

A focal co-ordinate reference plate and a reference chart are used in conjunction with the radiographs to provide the proper mechanical recording of measurements which are necessary to locate the foreign body in three-dimensional space.

This apparatus was fully described by Dr. Sweet in recent articles in the *Archives of the Röntgen Ray* and elsewhere, so that a full description is omitted here.

Another development which within the last two years has made great headway in both Europe and in this country has been stereoscopic radiography. This has been due to a comparatively recent recognition of the correct optical principles which underlie proper technique in this work. Some form of Wheatstone stereoscope is usually employed.

The obvious advantages of this method of procedure in radiography do not require elaboration. The advantage of having the parts radiographed in three dimensions,—that is, stereoscopically,—is very great in the cases of fractures, foreign bodies, skull and lung examinations.

Recent developments in the quality of intensifying screens have enabled the X-ray operator to increase the speed with which he makes radiographs, so that about one-fourth the former time of exposure is required. The modern intensifying screen consists, usually, of a piece of cardboard, one side of which has a coating of calcium tungstate.

Mr. Edison and others, shortly after Röntgen made his discovery, experimented with various kinds of intensifying screens.

The crystals of these early intensifying screens were too large to be of practical use, because of the mottling which they produced on the photographic plates. The surface of the early screens was very rough indeed, while the surface and the size of the particles in the sensitive side of the modern intensifying screen are usually smaller than the grain of the photographic emulsion. The modern screen, therefore, does not cause an appreciable mottling of the photographic plate.

The radiographs are usually taken with the radiation passing through the photographic plate before the radiation strikes the screen, because of the fact that X-ray absorption of the tungsten salt is greater and less uniform than the absorption of the glass plate and the photographic emulsion. These screens all give a bluish-white light, so that they are quite efficient in producing actinic effects upon the photographic emulsion.

The developments in X-ray tubes recently appearing include the so-called Bauer air regulator, which is a device for admitting ordinary atmospheric air into X-ray tubes from time to time when the vacuum of the tube needs reducing.

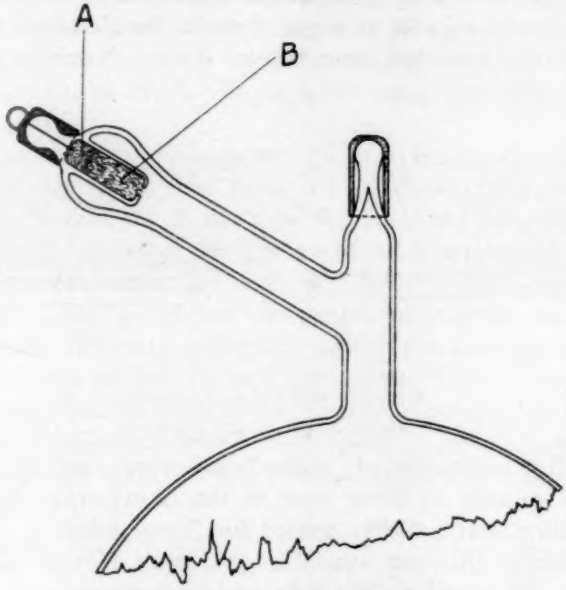
The regulator has attached to it a large rubber tube and a rubber bulb or other device that may be squeezed in order to compress the column of air in the rubber tube, which in turn pushes a small column of mercury in a capillary tube, and this by its movement exposes a plug of porous material through which a small amount of atmospheric air may diffuse into the X-ray tube.

This regulator has proved to be quite satisfactory and is used to a large extent in Europe, because of the fact that atmospheric air gives a better characteristic to the vacuum of the X-ray tube than the gases admitted by the ordinary chemical regulators previously in vogue. This is a deserving and meritorious improvement which has added to the ease and convenience of reducing the vacuum of the X-ray tube.

Now I have the privilege of calling your attention to what I think is the first really commercial application of radium. This, I believe, is the first announcement, and it gives me very great pleasure to have the privilege of making it to The Franklin Institute. Briefly, it is the use of a powdered uranium-radium ore in the X-ray tube regulator as a gas-producing material to liberate gaseous helium at the will of the X-ray operator.

Referring to Fig. 3, *A* is a mass of powdered clevite, Bröggerite, or other ore which, due to atomic disintegration, is constantly producing within its own volume gaseous helium or other monatomic gas. This mass of powdered mineral is mixed with a small percentage of asbestos wool in order to introduce appreciable resistance between the highly-conducting particles of crushed ore. *B* is a packing of asbestos wool for the purpose of holding *A* mechanically at the upper end of the

FIG. 3.



Helium Regulator for X-ray tubes.

A, powdered solid containing helium gas; *B*, plug of asbestos.

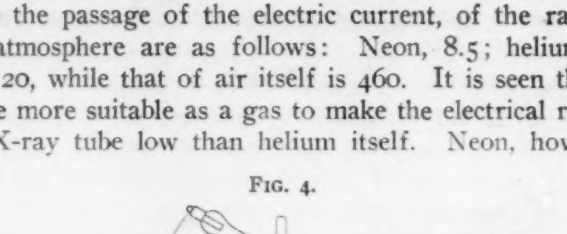
glass tube within which it is contained and to keep it in contact with the conductor which leads to it through the glass seal.

Uranium is the atomic parent of radium. Radium likewise breaks down and evolves helium, due to atomic disintegration. Clevite and Bröggerite are two of the minerals which occlude the helium gas as rapidly as it is formed within its own volume. These minerals will yield this gaseous helium upon heating or upon being dissolved in strong acids. In the X-ray tube regulator the powdered mineral conveniently retains the self-gen-

erated helium gas until it is required and liberated by passing a high-tension discharge through it, which liberates the gas by heating.

The advantage which gaseous helium has in an X-ray tube is the fact that its resistance to the passage of the electric current is small as compared with the common gases or any other gases that are readily available. The dielectric cohesions, or resistances to the passage of the electric current, of the rare gases of the atmosphere are as follows: Neon, 8.5; helium, 18.5; argon, 120, while that of air itself is 460. It is seen that neon would be more suitable as a gas to make the electrical resistance of the X-ray tube low than helium itself. Neon, however, is

FIG. 4.



X-ray tube with Helium Regulator.

A, Anode; *K*, Kathode; *R*, Regulator.

not readily obtainable, is exceedingly rare, and is not conveniently capable of being used in the X-ray tube in even the small commercial quantity needed for X-ray tubes.

Helium is the best available gas, since Nature has kindly provided the uranium minerals which generate and hold the helium gas until it can be liberated in a tube regulator, in the manner above described.

I make this statement because I believe that the dielectric cohesion of neon is the lowest of all the known gases, and because helium is next to neon in its low electrical resistance.

The so-called "crankiness" of X-ray tubes which X-ray operators find in the case of old X-ray tubes is due to the presence in the X-ray tube of gases of very high dielectric cohesion. These gases are set free by electric discharge through X-ray tube regulators provided with mica, or asbestos, near the end of the life of these gas-producing materials when used

as such in X-ray tube regulators. Glass itself gives off gas having very high dielectric cohesion when the glass is heated in a vacuum. Since this condition exists in an X-ray tube when strongly operated, the inner surfaces of the walls of the X-ray tube liberate gases having high electrical resistance and thereby producing the so-called "cranky" tube.

Tubes with these helium-radium-uranium regulators do not exhibit the crankiness above described and give a larger percentage of X-ray energy output for a given input of electrical energy than X-ray tubes otherwise identical except of the kind of gases used to regulate them. This increase in X-ray energy output for a given electrical energy input is approximately 20 per cent. as compared with similar X-ray tubes using atmospheric air for their regulation.

It is an exceedingly fascinating idea to realize that the helium gas within an X-ray tube using one of these radium regulators is obliged within the X-ray tube for a second time to perform the function of being the matter or stuff connected with the production of corpuscles and positively-charged carriers of electricity. In the atomic disintegration of the radium this helium was the very identical matter constituting the alpha particles given off by the radium. Now in the X-ray tube it is again required to furnish the material from which are made the positive particles which correspond to the alpha rays of radium and the kathode rays which correspond to the beta rays of radium.

Discussion.

DR. GOLDSCHMIDT.—I would like to ask how recent that fluorescent screen is.

MR. SNOOK.—This calcium tungstate intensifying screen has been in practical use really since 1910, but the practical development of the screen so that it would withstand rough usage has occurred only within the last year. The matrix,—that is to say, the binder, with which the crystals of the salt were held together,—was originally a soluble gum. The result was that finger-prints would show very quickly. The later screens, which have been made practical this year, have had a matrix of celluloid or nitrated cellulose, so that they are quite durable, and

do not show finger-prints. They actually can be wiped with a damp cloth.

A MEMBER.—I am surprised about the statement that the small crystals are visible. Years ago I examined such a plate with a contact lens, and I could not see any crystals; I could see a fine powder.

MR. SNOOK.—That is really true. It is practically large crystals powdered; but in the powder one finds many very fine crystals.

A MEMBER.—Well, sulphide of zinc is used for the same purpose, is it not?

MR. SNOOK.—No, it is too strongly phosphorescent, and does not exhibit so high an efficiency; it is not an efficient transformer of X-rays into light.

Q.—It is rather weak, is it not?

A.—Yes.

MR. HORNOR.—Do you use tungsten electrodes?

MR. SNOOK.—There are so many things that might have been brought to your attention, and I beg your pardon for having failed to call your attention to that phase of the subject.

The focus spot of the X-ray tube must be made of a material that will withstand very high temperatures. It must also be strong mechanically and have good thermal conductivity. Such a material, with better thermal conductivity and with a higher melting point and better mechanical properties than the material we have used until a year ago, is to be found in the ductile tungsten which has been placed on the market by the General Electric Company. The material which was used prior to the use of tungsten was usually platinum or a platinum-iridium alloy. Perhaps 20 per cent. was the highest successful percentage of iridium alloyed with platinum. Iridium has a higher melting point than platinum, and alloyed with platinum raises the melting point and thus makes a target with good resistance.

Prior to the introduction of tungsten the target had a melting point of about 1750° centigrade, whereas the melting point of tungsten is approximately 3000° C. When you realize its thermal conductivity,—that is, when you consider the ability of the metal to conduct the heat away from the focus spot (the tungsten has about twice that of platinum when the tungsten is first placed in the tube),—it has an enormous advantage over

platinum or its alloys that has been an exceedingly great help.

MR. G. R. HORNOR.—Did I understand you to say that helium made a tube more efficient than argon?

MR. SNOOK.—Considerably. And argon is more efficient than atmospheric air, and atmospheric air is more efficient than the oxygen which is obtained from such materials as potassium chlorate, manganese dioxide, and other chemicals which on heating will give off gaseous oxygen. Argon is more efficient than nitrogen, but helium is the most efficient gas I have been privileged to use.

MR. HORNER.—Did you say that radium itself disintegrates into helium gas?

MR. SNOOK.—Yes, it does. One of the earliest experiments was to place some radium in an X-ray tube, and the idea was to utilize the helium given off by radium. Radium, however, does not hold gaseous helium, but gives it off freely, and therefore the free gas in the tube constantly became of greater and greater pressure and the vacuum went down in a most disappointing manner; whereas with the minerals we use the helium does not become a free gas until the mineral is heated by the electric discharge, when desired.

MR. HORNOR.—How do you introduce the free gas into the tube?

MR. SNOOK.—I will demonstrate by the tube on the machine. (*Practical demonstration.*) It will be seen that the main terminals of the generating apparatus are directly connected to the main terminals of the X-ray tube. It will be seen also that the regulator terminal is insulated by not being connected to anything. If now I rotate this arm, so as to get the high tension over from the anode to the regulating terminal, I can pass the discharge through the X-ray tube regulator. I will demonstrate this. (*Demonstration.*)

Now, changing the connection back, we measure the parallel spark gap in that distance, and it is less than 2½ inches. Changing it back and lowering it again, we have a little over 1½ inches.

Soldering Aluminum by a New Aluminum Alloy. ANON. (*Sci. Amer.*, cvi, 22, 491.)—An English method of soldering aluminum, especially applicable to electrical conductors of this metal, is claimed to produce a permanent contact and to withstand the most searching atmospheric and chemical tests. Recognizing that many attempts hitherto made have failed on account of the aluminum oxide that creeps under the coating of solder, and destroys the contact, the new method employs a solder composed of an alloy of aluminum and the necessary flux, and is applied as a paste. The heat of an alcohol lamp or gasolene blow-torch, or the acetylene-oxygen welding flame (for large work), causes the solder to run freely into the joint; and in connecting heavy-stranded aluminum cables a special method is employed whereby molten aluminum is poured into the joint.

Researches on Glass and Porcelain Insulators. G. REBORD. (*Atti dell' Assoc. Elettr. Ital.*, xiv, 665.)—Experiments were made on the electrical and physical properties of glass and porcelain insulators of European and American manufacture. To clear up some discrepancies on the disruptive voltages obtained with needle points by H. W. Fisher, new experiments were made with points really pointed and not blunt, such as were frequently found in commercial needles. A table, and the curve plotted therefrom, are given, showing the results obtained, which are expressible in these formulæ: from 0 to 25 kilovolts $X = 1.3\ V$, where V is effective pressure in kilovolts and X the sparking distance in mm.; from 50 to 150 kilovolts $X = 3.2\ (V-25)$; a third, less accurate formula for voltages between 30 and 50 kilovolts is $X = 2\ (V-10)$. The summary of the insulator tests may thus be given. Glass insulators have a superficial resistance not inferior to that of porcelain under various conditions of humidity, and the glass does not retain moisture to any greater extent. The sparking distances over glass and glazed porcelain are from 10 to 30 per cent. lower than the sparking distances in air; ebonite, ambroin, and unglazed porcelain show similar behavior. When smooth, the curved surfaces of glass and porcelain are equivalent. The mechanical strength of glass is satisfactory and the surface is unattackable, but glass will not stand sudden jumps in temperature as well as porcelain does.

Melting Point of Copper Oxide. R. E. SLADE and F. D. FARROW. (*Z. Electrochem.*, xviii, 817.)—Pure cupric oxide does not melt below 1148° C. At this temperature, even with a pressure of 2.5 atmospheres of oxygen, decomposition occurs, producing cuprous oxide, which forms a solution with the cupric oxide solidifying at about 1081° C. At 1 atmosphere the decomposition begins at 1090° C., and the solution, containing over 50 per cent. of cuprous oxide, solidifies at about 1064° C. This is the value given for the true melting point of copper oxide by Wöhler.

SAFETY OF LIFE AT SEA.[1]

BY

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Member of the Institute.

THE subject of the safety of life at sea is at the present time a very interesting and important one. It will be found, after investigation, that a greater amount of attention has been given by the various nations to this subject than is generally known by the public.

A historical review of the means of saving life at sea before the days of iron and steel ships would not be of interest to us, seeing that the conditions are so different as regards the capability of the wood vessel to float longer than the iron and steel one in case of accident, owing to the material used, and to the fact that wooden ships had more freeboard. The history of the safety of life at sea, therefore, only concerns us from about the year 1850.

In order to place before you in a concise way the laws, etc., relating to the safety of life at sea, your attention will be directed to those of Great Britain, as described in Blue Books lately issued, and this information will be useful in our consideration of the navigation laws of the United States.

We find in the history of transportation on land that regulations had to be made as regards safety of life on railways, street cars, etc., as the different means were developed. The same applies to transportation on the ocean. The great pity is that these laws are always amended to suit the developments of the business after some terrible sacrifice of life due to want of forethought.

In order to ensure safety of life at sea consideration must be given to the vessel generally and in detail, and to all that affects her navigation; the following list will give you an idea of the subjects relating to safety:

Stability, with special reference to vessel in light condition and worst possible loaded condition; stability of passenger vessels

[1] Presented at the meeting of the Mechanical and Engineering Section held Thursday, October 24, 1912.

with majority of passengers on upper passenger deck; stability of vessels in rough weather.

Freeboard, or amount of reserve buoyancy, with special reference to cargo vessels in rough weather.

Design, as regards subdivision into watertight compartments; design, as regards sanitation; design, as regards ventilation; design, as regards area of living spaces.

Construction, as regards quality and strength of materials; construction, as regards scantlings of structure.

Equipment, as regards instruments for navigation; equipment, as regards lights for navigation; equipment, as regards means of fire prevention in passenger and freight spaces; equipment, as regards life-boats, etc., and launching of same.

Manning, as regards crew and duties of crew.

Inspection of materials at mills; inspection of construction in ships; inspection of vessel's equipment in ship; inspection of crew as regards capability; inspection of vessel annually; inspection of vessel when sailing from and arriving in port.

As it would be impossible to take up all these subjects in detail in one paper, it is proposed to place before you a general outline of what has been done by Great Britain and the United States as regards ensuring safety of life at sea, more particularly by means of life-saving appliances and by the watertight subdivision of vessels.

As regards safety of life at sea, your attention is now directed to what has been done in the Merchant Marine of Great Britain:

In July, 1912, the British Government appointed a committee, called the Merchant Shipping Advisory Committee, and it was asked to report on the statutory regulations as to boats and life-saving appliances and the means of ensuring safety of life at sea. This committee consisted of representative shipowners, shipbuilders, marine engineers; and members of the Board of Trade, of classification societies, and of chambers of shipping. This committee was assisted by representatives of the British Admiralty, Post Office, Meteorological Office, Hydrographic Office, and by wireless experts. Sub-committees were formed to report on type of open life-boats, wireless telegraphy, steamship routes, home-trade passenger ships and statistics.

The sub-committee on statistics reported that "in 1855 there were three sets of regulations in force, dealing with:

"*First.*—Vessels carrying emigrants.

"*Second.*—Other vessels carrying passengers.

"*Third.*—Seagoing vessels not carrying passengers.

"The first regulation contained a boat scale regulated by the tonnage of the vessel, but no greater number of boats was necessary than sufficient to carry all the persons (crew as well as passengers) on board the vessel.

"The second regulation contained a boat scale regulated by the tonnage of the vessel, and was drawn up for vessels up to 1,000 tons; no requirement was made that the boats should be sufficient to carry all persons on board the vessel, but the Board of Trade always required additional life buoys and buoyant deck seats, etc., to be carried on home-trade passenger ships carrying large numbers.

"The third regulation contained a boat scale identical to that required by the second regulation, but this was not enforced, as the Board of Trade had no power to enforce its observance."

In 1886 a committee appointed by the Board of Trade reported that a great number of vessels employed on the Atlantic service had not enough life-boat accommodation, though many shipowners fitted more life-boats than called for by the rules, and this committee recommended "that each ship shall have sufficient life-saving gear for all on board at any one time."

In 1887 a select committee of the House of Commons was appointed to report on saving of life at sea, and they reported "that many passenger ships could not, without great inconvenience, carry so many of the ordinary wooden boats as would suffice to carry the whole of the passengers and crew with safety in bad weather. Under such circumstances the crew would not be sufficient to man so many boats; nor could they all be gotten into the water in sufficient time, in the event of very rapid foundering. Having regard, however, to the fact that accidents occur probably as often in moderate weather as in bad, and having regard also to the fact that the very cause of the accident frequently incapacitates many of the boats, and to the further fact that an insufficiency of boats undoubtedly tends to cause panic, we are of opinion that all sea-going passenger ships should be compelled by law to carry such boats, and other life-saving apparatus, as would in the aggregate best provide for the safety of all on board in moderate weather."

As a result of the report of the select committee in 1887 new rules came into force in 1890. The boat scale then adopted was that in force in June, 1912, except that the maximum tonnage provided for was 9,000 tons. The table was, however, extended in 1894 to provide for vessels of 10,000 tons. But as regards emigrant ships, there was a rule that if there was not life-boat accommodation for all on board, additional boats or rafts were to be carried, and these additional boats or rafts should have carrying capacity so that they and the boats required by the table should provide three-fourths more than the minimum capacity required by the table. This rate was no doubt worked out so as to have life-boat capacity generally for all on board, but ships increased in size and the rule did not apply.

In the report of the select committee of the House of Commons in 1887 the following reference was made to watertight bulkheads:

"Though the question of construction was clearly not included in the reference to the committee, still they think it only right to state that, having heard the evidence, the proper placing of bulkheads, so as to enable a ship to keep afloat for some length of time after an accident has occurred, is most important for saving life at sea, and a thing for which the full efficiency of life-saving appliances largely depends." This recommendation is responsible for the rule in the merchant shipping (life-saving appliances), October, 1888, as follows:

"WATERTIGHT COMPARTMENTS.—When ships of any class are divided into efficient watertight compartments to the satisfaction of the Board of Trade, they shall only be required to carry additional boats, rafts, and buoyant apparatus of one-half of the capacity required by these rules; but the exception shall not extend to life jackets or similar approved articles of equal buoyancy suitable to be worn on the person."

Shipowners were not required to build to this rule; they could carry life-boats according to the boat scale based on the tonnage of the vessel, or they could take advantage of the rule specifying watertight bulkheads and requiring boat capacity for one-half the capacity required by the boat scale rule. Speaking generally, recourse to this watertight compartment rule by shipowners has been so insignificant that the rule may be regarded as of no practical account.

In 1890 a committee, called the Bulkhead Committee, was appointed by the British Government, and consisted of practical men experienced in the latest practice of ship design, shipbuilding, and marine engineering. The report made by the Bulkhead Committee is a valuable addition to the subject of safety of life at sea. Their report contains recommendations regarding how vessels should be grouped for watertight subdivision, with tables giving the spacing of bulkheads. The report also contained recommendations regarding bulkhead decks, longitudinal bulkheads, sidelights, freeboard, openings, and construction of bulkheads.

The watertight subdivision of steamers to ensure more safety of life at sea was not used in the design of ships until after the Bulkhead Committee report was issued. This committee simply made recommendations which were never included in any law. A number of owners of passenger vessels followed these recommendations in vessels operated in the British Channel services and in vessels on the Atlantic Ocean trade with the idea of attracting business.

After 1894 passenger steamers were built of larger tonnage than 10,000 tons, and increased to 40,000 tons at the present time. The reasons given for not increasing the life-boat capacity to meet the larger number of passengers carried are:

There was a small loss of life under the prevailing regulations.

Vessels were stronger and had watertight subdivisions.

Not considered possible that a larger number of life-boats could be rapidly dealt with at sea and could be safely housed without encumbering the decks unduly.

Vessels were safer owing to definite routes being agreed upon.

Vessels were fitted with wireless telegraphy, ensuring assistance.

If more boats were carried it would not be possible to man them in case of accident.

Vessels were fitted with twin, triple and quadruple screws, ensuring more chances of proceeding in case of accident to machinery.

In 1910 and 1911 a number of recommendations were made to increase the life-boat capacity of passenger steamers, but none of these were enacted into law.

The above-mentioned rules appeared to be sufficient to en-

sure safety of life at sea, according to statistics made by the Board of Trade, until we come to the *Titanic* disaster.

It will be interesting to quote some particulars regarding sea casualties from the Board of Trade returns. The following is a summary of the vessels registered in the United Kingdom which were totally lost at sea or met sea casualties attended with loss of life during the twenty years ended June 30, 1911, while on voyages between European ports and ports on the east coast of the United States, Canada, and Newfoundland:

	Number of casualties.	Number of lives lost. Crew.	Pass.	Total.
Sailing vessels	100	221	7	228
Steam vessels	332	1,349	78	1,427
	432	1,570	85	1,655

The casualties are divided into:

Founderings	51
Strandings	115
Collisions	17
Other causes	201
Missing vessels	48
	432

Under "Other causes" there do not appear to have been more than about 29 in which boats could have been of assistance in saving life. Referring to the 85 passengers lost, 44 of these were lost in one vessel which stranded on the Manacles in Cornwall, England.

Another return relating to the home-trade or excursion passenger steamers registered in the United Kingdom which met with casualties attended with loss of life during the twenty years ended June 30, 1911:

	Number of vessels	Number of lives lost		
		Crew	Passengers	Total
Founderings	1	21	14	35
Strandings	8	104	273	377
Collisions	13	8	44	52
Other causes	13	18	10	28
Totals	35	151	341	492

In 30 out of the 35 cases boats and buoyant deck seats were sufficient to accommodate all persons on board.

Another return showing the number of sea casualties involving loss of life to vessels registered in the United Kingdom reported to the Board of Trade during the twenty years ended June 30, 1911, as having occurred *everywhere* through contact with ice:

Out of 858 casualities through contact with ice, only 3 entailed loss of life, and the total number of lives lost being 6.

Of the vessels totally lost, 13 were lost through striking ice on voyages between European ports and the east coast of the United States, Canada, and Newfoundland, and in these 13 casualties there was no loss of life.

The recorded number of passengers carried almost entirely in British vessels between the United Kingdom and ports in the United States and British North America during the years 1892–1911 was 9,390,094. The total number of passengers who lost their lives from all casualties to British vessels in the North Atlantic was 85.

Then in April, 1912, occurred the greatest marine disaster that ever happened, in the loss of the passenger steamer *Titanic* and 1,490 lives after colliding with an iceberg in the North Atlantic Ocean. Details of the vessel and description of the voyage and of the disaster will be found in the Reports of the Enquiries made by the United States and British authorities.

The British Government appointed the Merchant Shipping Advisory Committee in July, 1912, already mentioned. This committee recommended in the case of steamships carrying emigrant passengers and foreign-going passenger steamships not carrying emigrants that:

First.—The stability and seaworthy qualities of the vessel itself be regarded as of primary importance, and every provision made against possible disaster be subordinated to this primary consideration.

Second.—The existing scale based on gross tonnage of vessel

as revised be used in regard to number of boats carried under davits.

Third.—The existing scale regarding number of boats to be increased by the addition of collapsible boats and life rafts sufficient for all on board.

In the case of steamers carrying passengers in cross-Channel services, they should have sufficient accommodation to support 50 per cent. of the passengers and crew allowed within the limits of the home trade in life-boats, life-rafts or buoyant apparatus. It is also recommended in the case of these steamers in the winter, when they may have more passengers and crew than could all be carried in the buoyant apparatus, that these steamers should be fitted with wireless telegraphy.

In the case of steamers carrying passengers in estuaries or mouths of rivers the boats and buoyant apparatus should be sufficient to keep afloat at least 50 per cent. of total number of passengers and crew.

In the case of passenger steamers plying in inland waters buoyant apparatus should be fitted for 25 per cent. of the number of passengers and crew.

All other vessels to have life-boats sufficient to carry all on board.

Recommendations were also made relating to manning of ships' boats and drill, wireless telegraphy, routes, speed, inspection, etc.

UNITED STATES.

In the report of the Supervising General of the Steamboat Inspection Service dated 1905 we find a short history of the laws respecting safety of life at sea.

The act of Congress approved July 7, 1838, which provided for the inspection of the hulls and boilers of steam vessels, was the first legislation upon the important question of "better security of lives of passengers on board vessels propelled in whole or in part by steam." By this act the inspectors were appointed. This act provided for life-boats, signal lights, fire-pumps and hose, and also for rods or chains for steering gear. There were also rules made for inspection of boilers and hulls. Modifications were made to this act on March 3, 1843, regarding the steering apparatus. The act of Congress approved August 30, 1852, was

really the establishment of the Steamboat Inspection Service. This act provided for life-saving appliances, licensing of crew, and inspection of machinery. Modifications were made in 1853, 1864, 1865, and 1866. The act of Congress approved February 28, 1871, provided for the organization and administration of the Steamboat Inspection Service, and is the basis of our present practice. The effect of its operation has been to lessen the loss of life. The Supervising General, in this historical review in 1905, says that there yet remains much to be done toward the further protection of human life on shipboard, and recommendations were added to his review. Those referred to carrying petroleum in passenger steamers, vessel's certificates, marine boilers, crew, pumps, inspection, and fire-proof steamers. These recommendations referred chiefly to engineering rules which are very essential and the enforcement of which has saved a large number of lives, but no mention is made of life-boats, watertight subdivision, or freeboard.

We now proceed to a short description of the organization and administration of the Steamboat Inspection Service and to the laws and rules relating chiefly to construction, watertight subdivision, and life-saving by buoyant apparatus.

The law authorizing the supervision of the inspection of vessels is as follows:

1871 (R. S. 4402) "There shall be a supervising inspector-general, who shall be appointed . . . by the President, ... who shall be selected with reference to his fitness and ability to systematize and carry into effect all the provisions of law relating to the Steamboat Inspection Service, ..."

1871 (R. S. 4403) "The supervising inspector-general shall, under the direction of the Secretary of Commerce and Labor, superintend the administration of the steamboat-inspection laws, ... report . . . . to the Secretary of Commerce and Labor . . ."

1871 (R. S. 4404) "There shall be ten supervising inspectors, ... Each of them shall be selected for his knowledge, skill, and practical experience in the uses of steam for navigation, and shall be a competent judge of the character and qualities of steam vessels, and of all parts of the machinery employed in steaming." Each supervising inspector has a number of assist-

ants, who are called local inspectors of hull and local inspectors of boilers.

1871 (R. S. 4415) "The inspector of hulls shall be a person of good character and suitable qualifications and attainments to perform the services required of an inspector of hulls, who from his practical knowledge of shipbuilding and navigation and the uses of steam in navigation is fully competent to make a reliable estimate of the strength, seaworthiness, and other qualities of the hulls of vessels and their equipment deemed essential to safety of life in their navigation; and the inspector of boilers shall be a person of good character and suitable qualifications and attainments to perform the services required of an inspector of boilers, who from his knowledge and experience of the duties of an engineer employed in navigating vessels by steam, and also of the construction and use of boilers, and machinery and appurtenances therewith connected, is able to form a reliable opinion of the strength, form, workmanship, and suitableness of boilers and machinery to be employed, without *hazard* to life from imperfection in the material, workmanship, or arrangement of any part of such apparatus for steaming."

The territory embraced in the supervising districts is as follows:

"First District embraces all waters and rivers of the United States west of the Rocky Mountains, and the Hawaiian Islands.

"Second District embraces all the waters of Long Island Sound west of the Connecticut River and the tributaries thereto, that portion of Long Island lying west of Riverhead and the waters of the Atlantic Coast, rivers, and tributaries from Long Island to Cape Charles.

"Third District embraces the waters of the Atlantic Coast, rivers, and tributaries between Cape Charles and Cape Sable.

"Fourth District embraces the Mississippi River and tributaries from above Greenfield, Mo., to the head of navigation on the Missouri River, and to the head of navigation on the Illinois River.

"Fifth District embraces the waters of the Atlantic Coast, rivers, and tributaries from the eastern boundary of the United States to and including the Connecticut River, and that portion of Long Island east of and including Riverhead.

"Sixth District embraces the Ohio River and tributaries up

to and including Carrollton, Ky., and the Mississippi River and tributaries from Greenville, Miss., up to and including Greenfield, Mo.

"Seventh District embraces the Ohio River and tributaries above Carrollton, Ky.

"Eighth District embraces all the waters of the Great Lakes north and west of Lake Erie, with their tributaries.

"Ninth District embraces all the waters of the River St. Lawrence, Lakes Erie, Ontario, and Champlain, and their tributaries.

"Tenth District embraces the coast and tributary waters of the Gulf of Mexico, between Cape Sable and the mouth of the Rio Grande, and the Mississippi River and tributaries to Greenville, Miss., and Porto Rico."

1871 (R. S. 4405) "The supervising inspectors and the supervising inspector-general shall assemble as a board once in each year at the city of Washington, D. C. . . . . in January, ... for joint consultation, ... The board shall establish all necessary regulations required to carry out in a most effective manner the provisions of the laws relating to the Steamboat-Inspection . . . . and such regulations, when approved by the Secretary of Commerce and Labor, shall have the force of law." . . . .

The navigation laws of the United States consist of statutes passed by acts of Congress, and which statutes cannot be amended unless brought up before Congress in an act and voted upon.

From the above-quoted statutes referring to the duties of the supervising inspectors it will be seen that they must rigidly follow the statutes, and the supervising inspectors have the power to draw up new regulations (which are actually as compulsory and important as the statutes) in conference with the shipping and ship-building interest affected by the same. These new regulations are then submitted to the Secretary of Commerce and Labor, and, according to R. S. 4405, when they are approved by him they have the force of law.

To quote again from the navigation laws:

"*Part VI, Paragraph 113. Unseaworthy Vessels.*

"If any person knowingly sends or attempts to send or is party to the sending or attempting to send an American ship

to sea, in the foreign or coastwise trade, in such an unseaworthy state that the life of any person is likely to be thereby endangered, he shall, in respect of each offence, be guilty of a misdemeanor, and shall be punished by a fine not to exceed one thousand dollars, or by imprisonment not to exceed five years, or both, at the discretion of the court, unless he proves that either he used all reasonable means to ensure her being sent to sea in a seaworthy state, or that her going to sea in an unseaworthy state was, under the circumstances, reasonable and justifiable; and for the purposes of giving that proof he may give evidence in the same manner as any other witness. (This section shall not apply to fishing or whaling vessels or yachts—December 21, 1898, sec. 26.)"

"*Part VI, Paragraph 114. Inspection of Hulls and Equipment.*

"The local inspectors shall, ... carefully inspect the hull of each steam vessel . . . . and shall satisfy themselves that every such vessel . . . . is of a structure suitable for the service in which she is to be employed . . . . and is in a condition to warrant the belief that she may be used in navigation as a steamer, with safety to life, and that all the requirements of law . . . . are faithfully complied with; . . . ."

By referring to R. S. 4415 we read that the inspector of hulls must be a person who is fully competent to make a reliable estimate of the strength, seaworthiness, and other qualities of the hulls of vessels and their equipment deemed essential to safety of life in their navigation.

Taking the strength of vessels first, there are no regulations specifying what the materials or scantlings or inspection of the same should be, though if we look at the rules for the construction of life-boats we find every part specified in detail. Of course, it may be argued that it is not necessary to have a set of rules of scantlings, etc., as vessels are generally classed in some classification society for insurance purposes; but no mention is ever made in the regulations that vessels should be built of materials and scantlings equal to any classification society's rules. It evidently was expected, according to the reading of the statute, that the local inspector was to estimate the strength and pass on the same, but he has not the time besides his other

duties, and it would mean that every inspector would have to make a set of tables, etc., for his own district. Again, the same Statute 4415 says that the local inspector is to be competent and make reliable estimate of the scantlings and other qualities of the hulls necessary for safety of life. This again brings in the question of strength and also freeboard, a subject that is not mentioned in the navigation laws. The majority of vessels at present have high freeboard on account of the type of vessel used in the coasting trade, but a large number of freight steamers are in existence and being built which can be loaded to any draft, irrespective of safety. All other nations have rules regulating the freeboard. Among "the other qualities of the hulls" mentioned in the statutes there is a very important one in the subdivision of vessels by watertight bulkheads. This requirement was forcibly brought out in the *Titanic* disaster, and, in my opinion, is the most important means of ensuring the greatest safety of vessels at sea, whether in fogs, collisions, or grounding. There is no mention made in the navigation laws of double bottoms, a prevention that has been in practice for 25 years in vessels of other nations.

This subject of watertight subdivision has been thoroughly investigated, and vessels of the U. S. Navy have been and are now subdivided into watertight compartments so as to ensure the greatest safety in case of accident. As already mentioned, the British Government, in 1890, appointed a Bulkhead Committee to report and draw up rules for subdivision of vessels by watertight bulkheads. By reference to this report it will be seen that it was assumed that vessels carrying passengers should be able to float when any two adjacent compartments were damaged and liable to be flooded. The report contained rules for the construction of watertight bulkheads to withstand the pressure of water that would result from such flooding of spaces. This basis of two adjacent flooded compartments was assumed, as it appeared to suit the worst condition that would happen, and was not placing such rigid requirements that would hinder a vessel from being a paying proposition in the carriage of passengers and freight. And the subdivision was not enforced by law, as new vessels would be at a disadvantage compared with vessels built before the report was made. Passenger steamship companies followed the recommendation so as to ensure safety to their passengers

and attract business. The recommendations as drawn up in 1890 worked well, as shown by the results of many collisions between vessels so subdivided. The case of the *Titanic* was an exceptional case and one never likely to happen again when so many compartments were cut open to the sea by collision with an iceberg. These recommendations by the British Bulkhead Committee were adopted by the German Government.

By referring to the United States Statute 4490:

"Every seagoing steamer, and every steamer navigating the great Northern or Northwestern lakes, carrying passengers, the building of which shall be completed after the twenty-eighth day of August, eighteen hundred and seventy-one, shall have not less than three watertight cross-bulkheads, such bulkheads to reach to the main deck in single-decked vessels, otherwise to the deck next below the main deck; to be made of iron plates, sustained upon suitable framework; and to be properly secured to the hull of the vessel. The position of such bulkheads and the strength of material of which the same shall be constructed shall be determined by the general rules of the board of supervising inspectors."

Then when we refer to the general rules and regulations prescribed by the board of supervising inspectors—Rule III, paragraph 31—we find a new rule added, evidently influenced by the *Titanic* disaster, and not even conforming to the recommendations made in 1890 by the British Bulkhead Committee to which the *Titanic* was built:

"Every seagoing steam vessel, and every steam vessel navigating the great Northern and Northwestern lakes, constructed after July 1, 1912, carrying passengers, shall have a watertight collision bulkhead. In vessels not over 200 feet in length this bulkhead shall be located about one-tenth the vessel's length from stem. In vessels over 200 and not over 300 feet in length the collision bulkhead shall be located about one-twelfth the vessel's length abaft the stem. In vessels over 350 and not over 500 feet in length it shall be located about one-fifteenth the vessel's length abaft the stem, and in vessels over 500 feet in length, about one-sixteenth the vessel's length abaft the stem. Such vessels shall also have one watertight bulkhead forward of and one abaft the engine and boilers, and, in addition thereto, shall have such other watertight bulkheads as may be necessary to provide that there

shall be no space between the bulkheads to exceed in length one-fifth the length of the vessel: *Provided,* however, That in no case shall the distance between the bulkheads be greater than 80 feet.

"Screw steamers shall, in addition to the above-mentioned bulkheads, have located at a suitable distance forward from sternpost a watertight bulkhead to protect vessel from disaster in case of fracture of stern pipe.

"All such bulkheads shall be of iron or steel plates not less than ¼ inch thick, and shall be securely fastened to suitable framework, which framework shall be properly and securely attached to the hull. Such bulkheads shall be strengthened by vertical bars of not less than 3½-by-3½-inch angle iron, spaced not more than 30 inches from centre to centre, and all steamers that are more than 10 feet deep in any hold shall have horizontal angle irons of not less than 3 by 3 inches on the reverse side, spaced not more than 4 feet from centre to centre, in addition to the vertical angle irons.

"*Provided,* That when any bulkheads are constructed of equal strength to the above-described bulkheads, they shall be allowed by the local inspector.

"All bulkheads shall reach to the main deck in single-decked vessels, otherwise to the deck next below the main deck, but in every case they shall reach to the deck next above the deep load line."

The rule specified under this paragraph 31 is open to very much criticism, as it does not ensure that all vessels built to this rule will float if any two adjacent compartments were flooded.

The paragraph specifying the scantlings of bulkheads is altogether inadequate for bulkheads required to withstand a high pressure of water after the vessel is flooded.

The paragraph specifying the height of bulkheads is not definite enough, as the main deck of a vessel is not specified anywhere in the statutes or rules, and a deck might be taken as the main deck that would not ensure safety after flooding the compartments. The latter part of this paragraph saying that "in every case the bulkheads shall reach to the deck next above the deep load line" is not definite enough, as the "deck next above the deep load line" may only be a few inches above the deep load line.

Evidently considerable thought has been given to the subdivision by bulkheads, but why not consider such an important subject carefully and have a committee of experienced shipowners and shipbuilders appointed by the Government to draw up the necessary regulations?

The subdivision of the vessel by watertight bulkheads, the construction of the bulkheads, and the fitting of double bottoms should be carefully considered, as it is necessary to safeguard the large number of passengers carried on steamers on the Atlantic and Pacific coasts.

It would astonish you and the public to know what would happen to the majority of the passenger steamers running on the Atlantic and Pacific coasts if two of them collided. It is surely not necessary to wait till there is a great loss of life before this question is taken up seriously and the rules amended.

Referring to Rule III, paragraph 31, quoted above, it is not clear that ferry-boats or river steamers such as run in New York Harbor, San Francisco Bay, or the Chesapeake require to have watertight bulkheads for safety. These vessels may be in collision in a fog, say between the Battery and Staten Island, on the Hudson River, or between Oakland and San Francisco, and if divided up so that they would float with any two compartments flooded a great loss of life might be averted.

The author of this paper made suggestions in February, 1905, to the Board of Supervising Inspectors as regards the safety of life at sea, and drew up rules for life-boats, freeboard, watertight subdivision, etc. A great many of these suggestions have been incorporated in the rules, but a considerable number of important rules has yet to be adopted. The recommendations made regarding bulkheads at that time are again made and are as follows:

"It is suggested that United States vessels be graded as herewith described:

"The following vessels shall be subdivided as described for Grade No. 1:

"Passengers and mail vessels navigating the ocean with limited freight only.

"All other passenger vessels navigating the ocean over 425 feet long.

"Passenger vessels on the Great Lakes and coast with limited freight only.

"Passenger vessels making short passages on the sea.

"Sound passenger vessels.

"Ferry-boats carrying passengers.

"Ferry-boats carrying passenger trains.

"Excursion vessels on estuaries and bays.

"River vessels carrying passengers and limited freight only.

"In connection with the above the following explanations are necessary:

"Limited freight shall mean an amount of freight, exclusive of passengers' baggage, not exceeding 25 per cent. of the gross registered tonnage in tons of 2,240 pounds each.

"The vessels described above shall be subdivided to float with any two compartments flooded, irrespective of their length.

"It is impossible to give the exact location of the bulkheads in actual measurements; in order to enable inspectors to perform this part of their duty, it will be necessary to work out series of curves of tabulated data to enable them to decide the proper location in each case.

"These curves will vary with several conditions, the principal being the density of the cargo and the height of the bulkhead deck above water. An average density of cargo will have to be assumed and corrections made for varying freeboards, all of which can be readily embodied in the curves referred to.

"All vessels of 350 feet length and less than 425 feet, carrying passengers and not falling under paragraph above, shall be subdivided so as to float in moderate weather with any two adjoining forebody compartments open to the sea.

"All vessels of 300 feet length and less than 350 feet, carrying passengers and not falling under Grade No. 1, shall be subdivided so as to float in moderate weather with any adjoining two of the three foremost compartments, or with any one of the other compartments, open to the sea.

"All vessels under 300 feet, carrying passengers and not falling under Grade No. 1, shall be subdivided so as to float in moderate weather with the two foremost, or any one of the other compartments, open to the sea.

"All freight vessels navigating the ocean and Great Lakes shall have a collision bulkhead forward, an after peak bulkhead

(except when the machinery is fitted right aft), and a bulkhead at each end of the machinery space.

"This rule is suggested because a closer subdivision would be detrimental to legitimate business interests; the close subdivision required for passenger vessels would in many instances, notably on the Great Lakes, practically kill all water carrying on a large scale. The registry societies prescribe certain bulkheads in vessels classed with them, the effect of these bulkheads being merely to delay a vessel foundering and not to make her unsinkable.

"The life-saving appliances prescribed in rule for life-boats are sufficient to care for the crew in the event of accident, and it is not necessary to do more, as by their calling they are more inured to hardship than the passengers.

"All vessels carrying freight only and not accounted for under above paragraph shall have a collision bulkhead forward.

"It is suggested that a table showing the limits of the different classes of navigation be drawn up for use in the administration of these rules and requirements, as it is practically impossible to make a general statement to meet all classes. This table is needed particularly to meet the case of vessels making voyages partly in rivers and partly at sea along the coast."

List of casualties (only those considered serious), as reported by the Steamboat Inspection Service:

		Lost lives.
1905.	Steamship *Peconic*, foundered off Florida coast	20
	Loss of steamship *Sevona* on Lake Superior	7
	Loss of steamship *Iosco* on Lake Superior	19
	Steamship *Valiyuga*, foundered in Lake Huron	17
	Steamship *Ira H. Owen*, wrecked in Lake Superior	19
	Steamship *Mataafe*, stranded near Duluth	9
1906.	Steamship *Valencia*, wrecked, Vancouver Island, B. C.	121
	Collision, steamship *Dix* and steamship *Jeanie*, Puget Sound	42
	Steamship *W. T. Scovall*, Vicksburg, Miss., boilers exploded	10
1907.	Steamship *Marion*, South Carolina, steamer burnt	12
	Steamship *Arcadia*, foundered on Lake Michigan	11
	Collision, steamship *Larchmont* and schooner *Harry Knowlton*, Block Island Sound	133
	Larchmont was damaged at fireroom, sank in less than ten minutes, only a few got away in the life-boats.	
	Collision, steamship *Columbia* and *San Pedro*, Shelter Cove, Cal.	86

	Steamship *Cypress*, foundered in Lake Superior, heavy gale..	22
	Steamship *Miriam*, on Mississippi River, struck by cyclone..	11
1908.	Steamship *H. M. Carter*, on Mississippi River, boilers exploded, ship took fire	11
	Steamship *D. M. Clemson*, foundered Lake Superior, severe storm	24
1909.	Fishing steamship *Geo. A. Floss*, sank in gale	7
	Tug *Eagle* capsized	8
	Steamship *Adelle Shores*, foundered in gale	8
	Collision, steamship *John B. Cowle* and *Isaac M. Scott*, Lake Superior	14
	John B. Cowle sank in three minutes.	
	Steamship *Clarion*, Lake Erie, took fire, 1 lost in fire, 14 lost in life-boat	15
	Steamship *Marquette* and *Bessemer No. 2*, never heard of....	30
1910.	Steamship *Czarina*, foundered Coos Bay Bar.....	24
	Steamship *City of Saltillo*, St. Louis, Mo., struck rock in Missouri River and sank	12
	Steamship *Frank H. Goodyear* and *James B. Wood*, in collision, Lake Huron	18
	Steamship *Pere Marquette No. 18*, Ludington, Mich., to Milwaukee, Wis., sank	27
	Steamship *Arkadia*, New Orleans to San Juan, P. R.	37
1911.	Three coal barges wrecked on Cape Cod	17
	Steamship *City of St. Joseph*, Mississippi River, boiler explosion	22
	Thirty casualties	819

Report	Lives Lost.						
	Fire	Collision	Explosions or accidental escape of steam	Break of steam pipes, etc.	Snags, wrecks, and sinking	Miscellaneous	Total
1911	10	46	42	..	114	69	281
1910	21	61	12	6	119	41	260
1909	3	37	9	7	68	73	197
1908	12	129	6	..	71	59	277
1907	31	193	27	3	55	63	372
1906	6	45	12	3	253	54	373
1905	14	35	14	..	33	41	137
Totals...	97	546	122	19	713	400	1897

During the years 1905–1911, when there was reported a loss of life of 1,897 persons from fires, collisions, explosions, wrecks, sinking, and miscellaneous, there is no doubt that if rules regulat-

ing the freeboard and subdivision had been in force there would have been a further great saving of life.

LIFE-BOATS AND BUOYANT APPARATUS.

Up till January, 1912, the rules of the United States Steamboat Inspection Service required a life-boat scale based on the tonnage of the vessel, similar to that in force in the British rules. On March, 1912, a new rule was made by the United States Steamboat Inspection Service that all steamers navigating the ocean must be provided with sufficient life-boat capacity to accommodate every person on board, including passengers and crew. This is an excellent rule, but has not been in operation long enough to effect much result.

As regards other steamers, the life-boats required were specified according to tonnage. In July, 1912, the following rules were passed regarding the life-boats required:

"All steamers other than steamers carrying passengers, except as otherwise hereinafter provided for, must be equipped with life-boats of sufficient capacity to accommodate at one time all persons on board. One-half of such equipment may be in approved life rafts or approved collapsible life-boats.

"Ocean steamers carrying passengers must be equipped with life-boats of sufficient capacity to accommodate at one time all persons on board, including passengers and crew. One-half of such life-boat equipment may be in approved life rafts or approved collapsible life-boats.

"Coastwise steamers carrying passengers must be equipped with life-boats of sufficient capacity to accommodate at one time all persons on board, including passengers and crew: *Provided*, however, That such steamers navigating during the interval from the 15th day of May to the 15th day of September in any one year, both dates inclusive, will be required to be equipped with life-boats of only such capacity as will be sufficient to accommodate at one time at least 60 per cent. of all persons on board, including passengers and crew; two-thirds of such required life-boat equipment throughout the year may be in approved life rafts or approved collapsible life-boats.

"Lake, bay, and sound steamers carrying passengers must be equipped with life-boats of sufficient capacity to accommodate at one time all persons on board, including passengers and crew:

Provided, however, That such steamers navigating during the interval from the 15th day of May to the 15th day of September in any one year, both dates inclusive, will be required to be equipped with life-boats of only such capacity as will be sufficient to accommodate at one time at least 30 per cent. of all persons on board, including passengers and crew: *Provided,* further, That such steamers navigating routes lying at all points within a distance of 5 miles from land, or over waters whose depth is not sufficient to entirely submerge the vessel in case of disaster, will, during the interval from the 15th day of May to the 15th day of September in any one year, both dates inclusive, be required to be equipped with life-boats of only such capacity as will be sufficient to accommodate at one time at least 10 per cent. of all persons on board, including passengers and crew. Three-fourths of the life-boat equipment required on lake, bay, and sound steamers may be in approved life rafts or approved collapsible life-boats.

" River steamers carrying passengers must be equipped with life-boats of sufficient capacity to accommodate at one time at least 10 per cent. of all persons on board, including passengers and crew. Three-fourths of such life-boat equipment may be in approved life rafts or approved collapsible life-boats."

The above rules appear to be sufficient as regards life-boats and rafts, but additional buoyant apparatus in the form of seats, etc., should be fitted in coastwise, lake, bay, sound, and river steamers and ferry-boats carrying passengers, so that there is buoyant apparatus for all on board all the year round.

As regards ferry-boats in services mentioned, buoyant tanks could be fitted which, together with the life-boats, would accommodate all on board, and these buoyant tanks could be stowed on top of the deckhouse. As regards large passenger steamers on sounds and rivers, deck seats on uppermost decks could be made buoyant and able to float off in case of accident.

The question of launching buoyant apparatus is a large one and would require careful investigation so as to suit all the conditions and services.

It is hoped that the information given in this paper will help and influence the proper authorities to take up the important question of " Safety of Life at Sea," with special reference to the construction and watertight subdivision of vessels and life-saving

buoyant apparatus and the launching of the same. Technical committees should be appointed by the Government to investigate and suggest regulations that may be enacted into law. It was in expectation of this being done that I took the liberty to place before the members of this Institute this important subject of the "Safety of Life at Sea."

Discussion.

Mr. G. W. Dickie, Naval Architect: Mr. Chairman: Although I have been many years a member of the Institute, this is the first meeting I have been able to attend. I am pleased to have the opportunity to speak on this very important subject, which has been presented to you in an able manner, both practically and historically, by my friend, Mr. Donald. There is nothing that I could add to the historical part of the paper, which part shows the difficulties connected with providing sufficient means of saving lives when a great passenger steamship has been mortally wounded by any accident that destroys the integrity of her hull.

It is unfortunate that the case of the *Titanic,* a case never before occurring and unlikely to occur again, should be used as the basis for a great deal of unwise legislation in regard to life-saving equipment. The inquiry should have been directed principally to the possibility of so improving the structure of the vessel as to render the need of life-saving apparatus a contingency much more remote than it is at present.

In looking at the plans of the *Titanic* it appears to me that ultimate safety was sacrificed to the convenience and comfort of the passengers. For instance, the transverse bulkheads forward of the engine-room enclosure were one deck lower than those aft. The reason for this is apparent when the bulkheads are considered in connection with the passenger accommodations.

The bulkhead question has always been a compromise between safety in case of an accident which may never happen and the everyday problem of working the ship and the everyday comfort of the passenger. The only absolutely safe bulkhead is the bulkhead that has no opening in it, and I am sure that a ship so built would not be popular among the passengers

on the lower passenger decks, while the problem of fore and aft communication between the engine- and boiler-rooms would not be easily solved.

A double skin without openings in the inner skin may yet be found to be the simplest solution. Whatever the answer may be to this problem, however, the safety of the ship herself should have first consideration, for with the ship safe, all the life-saving problems are settled.

Mr. Robert Haig, Surveyor, Lloyd's Registry of Shipping, Philadelphia: The question of "Safety of Life at Sea" is of the deepest concern to shipbuilders and owners, as it is also to those who travel in ships.

One has only to consider the efforts continually being made by both builders and owners to devise or develop such arrangements that will tend to give the vessel greater protection or stability in times of stress such as we have recently witnessed in the lamentable catastrophe to the steamship *Titanic.*

In a calamity such as the *Titanic,* the first impression is that there should be a greatly-increased number of life-boats, sufficient to take care of the entire passengers and crew, which in this vessel might have amounted to 3000 people, and, with an allowance of 50 people per boat, would mean that the vessel would require to be equipped with 60 boats, a number it would be impossible to handle in times of trouble and almost as difficult to find room on the deck of the vessel to stow the boats.

While it is possible some lives that were lost on the *Titanic* might have been saved if there had been more boats, it is a fact that is quite well known that many more lives would have been saved if the people could have been induced to get into the boats that the vessel was equipped with.

That the mishap to the *Titanic,* from a structural point of view, was almost impossible to guard against is amply borne out by the fact that, while the vessel was holed right forward, the extent of the damage in a fore aft line was sufficiently great to allow water to enter the machinery space, and it is hardly possible that any arrangement of bulkheads could have kept the vessel afloat with the hull plating pierced in so many of the

holds. There is no record that the bulkheads gave way, and there is every reason to feel confident they did not. Bulkheads are designed and constructed on well-established data deduced from exhaustive experiment and investigation, and wide experience has demonstrated that when well constructed they are sufficiently strong for the duty they have to perform and there is no doubt that in a type of vessel like the *Titanic* all of the work was of a high order. Experience would seem to indicate that in large, high-speed vessels when so much is at stake, the extra cost of extending the double bottom (or inner skin) up to or near the water line does not become nearly so important a factor as the greater security obtained.

No doubt, further subdivision by additional transverse or longitudinal bulkheads in large passenger or cargo vessels will be required at an early date, as there are many able brains working on the subject at the present time, and papers such as the one we are now discussing will serve a most useful purpose in assisting the development of this subject.

Naval Constructor Elliott Snow: It is generally conceded by naval architects that the most effective step toward securing the safety of life at sea lies in applying in a practical way the old adage " An ounce of prevention is worth a pound of cure " ; in short, in making the vessel itself as safe as possible, and thereby reducing to the very lowest limit the chance of having to resort to the life-saving equipment of the vessel.

This view is entertained because it is known and recognized that even with the most modern equipment of life-boats and safety appliances it is a very difficult and dangerous operation to lower a boat in any other than a comparatively smooth sea and during daylight hours.

As the subject dealt with in the paper was too large to permit of its being dealt with *in extenso,* the author has very wisely limited himself to a general outline only, and has dealt more particularly with the question of watertight subdivision and life-saving appliances,—that is, life-boats and other buoyant apparatus.

I heartily concur with the view expressed, that the sub-

division of the vessel by watertight bulkheads, decks, and double bottoms should be more carefully considered. U. S. Statute 4490, which prescribes bulkheads for certain classes of vessels, is clearly defective, and the rules that have been promulgated thereon are inadequate to provide for the safety of a vessel at sea as regards her watertight subdivision. The law is defective in that it is too limited in its requirements and it attempts irrelevant detail. The rules are inadequate in that they do not insure that all vessels built under those rules will float if any two adjacent compartments were flooded. *This requirement that a vessel will float with two adjacent compartments flooded should be required as a minimum.*

Summing up in a slightly different form from that given by the author, it appears that the safety of the vessel would best be promoted by careful attention to

(1) The design of the vessel;
(2) The construction of the vessel;
(3) The equipment of the vessel;
(4) The operation of the vessel;

the design, construction, and equipment being subject, of course, to careful inspection, and the operation also subject to inspection and further control by public opinion.

I think it would be unwise to enact further legislation until the whole subject of the watertight subdivision of vessels, both sea-going, those on the Great Lakes, and on the bays and inland waters, is given consideration by a board of experts. The deliberations of such a body would be materially assisted by consulting the records of the British Bulkhead Committee, drawn up in 1890, and the personnel of such a body of experts could be easily drawn from the members of the American Society of Naval Architects and Marine Engineers.

Mr. Ernest H. Rigg, Naval Architect, New York Shipbuilding Company: The history of legislation on this subject, when read between the lines, shows a natural hesitancy on the part of individual nations to enact laws that will handicap their own merchant marine in competition with that of other nations; for example, the British Freeboard Regulations have only been slowly adopted in the other countries and not even yet by this country: not that we should slavishly adopt any regulations,

providing we enact equivalents of our own, but this even has not been done.

The numerous international congresses which have been necessary to bring about practical uniformity in tonnage measurements of ships again show the difficulties of the question.

Since the loss of the *Titanic,* Great Britain and Germany have both been busy setting their houses in order. Everywhere, however, including America, too much attention has been concentrated on life-boats; the *Titanic* went down in a calm sea and the boats were effective; how many disasters have happened in weather too severe for boats to be launched and gotten away from the ship's side? What is wanted is such subdivision of passenger ships as will make them practically unsinkable; but this must be international to be effective. Great Britain, in her freeboard legislation, made a great business sacrifice for humanity's sake: she led the way, and gradually most of the leading maritime states have followed.

It is not to be expected, in the face of modern competition, that she will do it again on bulkheads.

Railroad regulation is a national affair, and therefore more easily handled; on the high seas all are equal, and therefore international agreement on regulations is necessary. Great Britain has a Bulkhead Committee again at work, and doubtless Germany is working on the same subject; are we? Enlightened and definite action on the part of the Secretary of Commerce and Labor is needed, looking toward the framing of regulations which will provide for safety at sea without arbitrarily imposing unnecessary handicaps on sea-borne commerce. Severe collisions have occurred and will occur again; there is no reason why they should be attended with unnecessary loss of life.

Wireless telegraphy helps greatly, but it is nothing but a trap, if the ships can't stay afloat till help comes.

The science of naval architecture is a vastly different thing to-day compared with even thirty years ago; steel has supplanted more difficult and less adaptable materials of construction, and ships have benefited greatly in the general engineering progress that has been made.

The *Great Eastern* survived as bad a smash as the *Titanic,* and that was sixty years ago. Battleships have done the same, size for size.

To make passenger ships more secure will cost money, and no individual nation or firm can undertake to bankrupt itself by going too far ahead of international regulations; but enlightened public opinion demands better ships than the *Titanic*, even at a fractional increase in the rate of fare to cover a higher standard of construction, and even if some of the latest elaborations of swimming pools and gymnasia are to be dispensed with.

The rates on the big, fast Cunarders are higher; it would be interesting to know how much is due to increased speed and how much to the increased safety, subsidized naval auxiliaries though they are; they command the confidence of the public, and consequently their patronage.

When quoting these large Cunarders and German ships it must always be remembered that they are subsidized as naval auxiliaries and could not get that subsidy without the subdivision that renders them so safe.

Mr. Donald's paper is a very painstaking presentation of the case, and the Institute is to be congratulated in being on record as interested in this great subject. It is to be regretted that we as a nation have not gone into the question in the same thorough manner as others, because it is poor sport following where others lead. The army authorities are conducting some investigations on life-saving appliances with a view to finding something of value for the Philippine transports.

The other gentlemen who have taken part in this discussion brought out many interesting points. In conclusion I should like to emphasize:

First.—The necessity for better bulkhead regulations in passenger-carrying vessels. This embraces the whole subject of subdivision, both vertical and horizontal.

Second.—The necessity for better boat provision than has been allowed in the past.

Third.—A general overhauling and modernizing of the regulations covering methods of communication, the state of development of which is advancing rapidly.

Fourth.—Manning regulations and conditions that will attract a good class of men as crew for passenger ships.

Fifth.—Increased steering and manœuvring power for merchant shipping.

Sixth.—The large ship has come to stay, and is more immune from disaster than the small one.

Seventh.—As evidence of the progress of the times, Lloyd's Register have recently completely revised and rewritten their regulations for building ships.

Eighth.—The subject of stability is well understood these days, and is not the bugaboo it was thirty years ago.

Ninth.—Experimental model tanks enable ships to be driven with less power for the same speed than was formerly the case. This saving could well go into bulkheads.

Tenth.—Fire protection on liners should receive better attention. The large German vessels are good examples in this way.

Eleventh.—Marine engineers can now produce a horse-power with less coal than formerly; could not some of this saving go into safety?

To summarize the whole thing, let shipping receive the benefit of modern scientific progress and development: not partially, but wholly.

New Method of Insulating Windings of High-voltage Machines. K. PERLEWITZ. (*Electrotechn. Zeitschr.*, xxxii, 1028.)—This article describes the method used by the firm of E. Hæfely, of Basel, in which Highfield's ideas are carried out. The air spaces between wires are completely filled to the exclusion of air by means of compound, and the coil is then wrapped with several layers of a foil termed "Micarta Folium," consisting of paper, mica, and enamel; the whole coil is then placed in a special machine, which is described, and compressed. The insulation is stated to be so good that a 3 mm. thickness will stand 65,000 to 70,000 volts if in separate wires, and 80,000 to 85,000 if formed of a single conductor.

The Choice of a Frequency. D. B. RUSHMORE. (*Amer. Inst. Elect. Engin.*, xxxi, 787.)—This article deals with the effects produced by the choice of a frequency on the lay-out and efficiency of a central station or power transmission scheme. The following points are considered, viz.: generators, transformers, transmission lines, lightning, induction motors, synchronous motors, frequency changers, railway work, switching phenomena, and illumination. The paper concludes with a list of frequencies used in many stations in the United States; and these frequencies are always either 25 or 60.

INDUSTRIAL FELLOWSHIPS: FIVE YEARS OF AN EDUCATIONAL INDUSTRIAL EXPERIMENT.[1]

BY

ROBERT KENNEDY DUNCAN, Sc.D.,

Director of Industrial Research and Professor of Industrial Chemistry at the University of Pittsburgh and at the University of Kansas.

SOME six years ago, at the meeting in Rome of the International Congress of Applied Chemistry, I thought out what appeared to be a sane, practical scheme of relationship between industry and learning for the purpose of promoting the increase of useful knowledge. As this scheme in its essentials is identical with that which I have since been privileged to realize in fact, the fundamental basis on which it was elaborated ought first to be presented.

Industry.

(1) At that time, generalizing as much as one may, American Industry, from the standpoint of efficiency and of progressive factory practice, was in a lamentable condition. The reasons for this condition were plainly evident:

(*a*) The existence of a high tariff which, whether good or ill for the people as a whole, certainly injured the efficiency of American manufacture by shutting out the competition of the efficiency of foreign manufacture working through the application of modern science.

(*b*) The creation of combinations for the elimination of competition and the consequent substitution of business intrigue for manufacturing efficiency.

(*c*) The existence of large stores of raw materials everywhere available.

(*d*) The needs of a rapidly-expanding population.

(*e*) The evolution of an area of extravagance in purchasing.

(*f*) An enormous development of the business of lying advertisement.

[1] Presented at the meeting of the Section of Physics held Thursday, October 3, 1912.

It was obvious, even then, that the American manufacturer resting upon such factors for success was in a precarious position, and that with the inevitable passing of such factors he could expect to survive only on a basis of efficiency.

Learning.

(2) But this efficiency, which means the conservation of waste, the bettering and cheapening of the products manufactured and the discovery of new and useful products to the manufacturer concerned, was not easily come by.

It could enter the factory only through the employment therein of men of high scientific and technical training, working in an atmosphere conducive to success—men who were genuine researchers inspired to solve practical problems. The universities of the country were not providing the industries with men of such qualities. It is true that they were sending out large numbers of men—chemical engineers, etc.—on the basis of a four years' college course, but such men were merely *taught* men; they were not researchers, and under the conditions of contemporary factory practice were deprived of the possibilities of development, and were, in fact, for the purposes of research merely ruined. The genuine researchers turned out by the universities, young doctors of philosophy with a record of successful academic research and with a proved capacity for creative work, were discouraged by the universities of any ambition to enter applied research and were led to consider the teaching profession as the only logical goal. A man of splendid training and of brilliant research qualifications who entered applied science—among whom are the few contemporary first-class research technologists—did so under the onus of academic disapproval. The reason for this lay in the fact that American science had through generations been built upon the basis of severe academicism and formalism. It was deemed contrary to university ideals and traditions that research should have in view any utilitarian end; there was great insistence upon *pure* science, the implication being that applied science was *im*pure and constituted a degraded form of research.

I am aware, of course, that I am discoursing very largely in this matter, but, making all due exceptions, the essential truth of these statements can hardly be a matter for dispute.

From the standpoint of applied science and for the immediate

future, with its radically changing conditions, industry, then, was in a deplorable way, and learning, as represented by its leading universities, both in spirit and in power, was little to be depended upon for serviceable help.

Under the circumstances, then, there seemed to be desirable some form of co-operation between industry and learning, so arranged that it might stand as a permanent relation.

Such an arrangement as originally presented by the writer may be found as the last chapter of "The Chemistry of Commerce" (Harper's). It was based upon a definite form of agreement between a manufacturing company and a university, providing for the establishment in the university for a period of two years, on the part of the company, of an "Industrial Fellowship"—the researcher concerned in this work being termed a Fellow.

Since the original presentation of this scheme, the agreement upon which it was founded has been discussed and argued back and forth through the offices of so many companies that while identical, in its main provisions, with its prototype, in its details it has become modified to correspond with what was learned as the development of the scheme proceeded.

In order to give the reader a clear idea of what I now regard as a reasonable relation for all concerned, I shall insert in this place, and for the first time, the agreement of an Industrial Fellowship which has recently been established at the University of Pittsburgh.

(*Form of Multiple Fellowship.*)

———— COMPANY'S INDUSTRIAL FELLOWSHIP AGREEMENT.

For the purpose of promoting the increase of useful knowledge, the University of Pittsburgh accepts from ——— COMPANY, having head-officers at ———, the foundation of a Multiple Industrial Fellowship, to be known as the ——— COMPANY'S FELLOWSHIPS.

It is mutually understood and agreed that the conditions governing this Multiple Fellowship shall be as follows:

The exclusive purpose of this Fellowship is ————————

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such problems to be stated by the Company in a separate memorandum to the Director of Industrial Research and acquiesced in by him.

To the furtherance of the problems of this Fellowship, the holders

thereof shall give their whole time and attention, with the exception of three hours a week, which each shall give to instructional work in the University.

The Fellows shall work under the advice and direction of the Director of Industrial Research, and they shall forward periodically, through the Director of Industrial Research, reports of the progress of their work to ——— COMPANY.

The Fellows shall be nominated by the Chancellor of the University and the Director of Industrial Research to the Board of Trustees of the University, which Board may appoint them to their respective positions in accordance with the terms of their formal letters of application to the Chancellor as approved by the Director of Industrial Research. They shall be provided with a separate laboratory and all supplies, reagents, etc., which might reasonably be expected to be in the possession of a large University, for the cost and payment of which their instructional services shall be taken in lieu. The donating company, on its part, undertakes to co-operate with the University in this research by providing the Director of Industrial Research and the Fellows of this Fellowship with its sympathy and with whatever knowledge of the subjects of research it may possess, and, on approval of the company, with its factory facilities for large-scale experimentation.

For the support of this Fellowship, which shall extend through a period of Two Years, ——— COMPANY agrees to pay FIVE THOUSAND DOLLARS ($5,000) per year to the University ANNUALLY IN ADVANCE ON ——— OF THE YEARS ———. All money paid in by ——— COMPANY under this Agreement shall be paid over by the University in monthly instalments to the holders of this Fellowship in such amounts as may be agreed upon by contract between the University and the Fellows concerned and, as well, on the order of the Director of Industrial Research, for such special apparatus related to this research as he may deem it advisable to purchase and for travelling expenses related to the elucidation of the problems concerned. On or before the expiration of this Fellowship the business services of any or all of the Fellows of this Fellowship may be secured by the donating company for a period of three years, on condition that the terms for such services are satisfactory to the parties at interest.

In the event that any money paid to the University in behalf of this Fellowship remains unexpended on the termination of the Fellowship, it shall be returned forthwith to ——— COMPANY.

Any and all discoveries made by the Fellows during the tenure of this Fellowship, as well as all information obtained by them germane to the subjects of their investigation, shall become the property of ——— COMPANY. But it is understood and agreed that the donating company obligates itself to pay to these Fellows considered collectively a maximum

CASH BONUS OF **$10,000,** or any part thereof which, in the opinion of the Board of Arbitration provided for in this agreement, is deserved by these Fellows, and that this Board of Arbitration shall decide the time or times in its payment. It is understood and agreed, however, that the estimation of the actual amount of this bonus shall not be made until——

The relative distribution of this bonus to the individual Fellows concerned shall be wholly within the power of the University to decide and determine.

In the event of any difference of opinion as to the interpretation of this Agreement, a Board of Arbitration is hereby provided for, which Board shall consist of a Representative of the University and a Representative of ——— COMPANY and a Third Person whom these two shall select. The decisions of this Board as to the interpretation of this Agreement shall be binding upon the parties at issue, and they shall obtain such decision before having recourse to the courts.

At any time during the tenure of this Fellowship, patents must be taken out at the option and expense of the donor, on condition that the patentee or patentees assign all rights to the donor under the conditions of this Agreement.

It is also understood and agreed that during the tenure of this Fellowship the holders may publish such results of their investigations as do not, in the opinion of the donating corporation and as acquiesced in by the Director of Industrial Research, injure its interests, and that on the expiration of the Fellowship the holders thereof shall have completed a comprehensive monograph on the subject of their research, containing both what they and others have been able to discover. A copy of this monograph shall be forwarded to ——— COMPANY, and a copy shall be signed and placed in the archives of the University until the expiration of three years from that date, when the University shall be at liberty to publish it for the use and benefit of the public. In the event that in the opinion of the donating corporation publication three years after the termination of the Fellowship would unduly injure its interests, it is at liberty to appeal for an extension of time to the Board of Arbitration provided for herein, which, after consideration of this appeal, is at liberty to extend the time of publication to a period which, in its belief, conserves the interests of all concerned.

DATED: SIGNED ON
BEHALF OF ——— COMPANY.

———— ————————

DATED: SIGNED ON
BEHALF OF UNIVERSITY OF PITTSBURGH.

———— ————————

A careful reading and re-reading of this agreement will make it evident that it relates to four different factors, and the degree to which it harmonizes with these different factors determines its acceptability and its chance of becoming a permanent relation.

These factors are:

(*a*) The University.
(*b*) The Company.
(*c*) The Public.
(*d*) The Researcher or Researchers engaged.

(*a*) *The University.*

The University is fulfilling its function in increasing the sum of knowledge; the fact that it is useful knowledge does not make it any the less valuable. Furthermore, the right to publish such knowledge is assured to the University under the agreement. An additional advantage lies in the large teaching force which, in accordance with the agreements, is provided for gratuitous instructional service in teaching chemistry. Still another advantage to the University lies in the relation of this system to its graduate school. Many of the "Fellows," as they are called, already hold graduate degrees; others, junior Fellows, hold Fellowships which are advisedly provided for young men who have just graduated from their college and who are men of promise. They are carefully chosen from the best universities and constitute, naturally, a strong element in a graduate school.

(*b*) *The Company.*

From the standpoint of the company, the system has gone past the experimental stage and now unquestionably constitutes a privilege; it has been demonstrated over and over that, working in accordance with this system, it is possible to accomplish results that cannot otherwise be obtained. And this is but reasonable.

The University is provided with an equipment for experimentation immeasurably larger than that in the possession of any but the fewest factory laboratories.

Equally important are library facilities, without which no research can progress. The University, as a matter of course, is in possession of the stores of past and contemporary scientific literature; factories, on the contrary, and with, let us say, half a dozen exceptions, are barren of such; factory sites are not

placed with a view to library facilities, and yet the lack of such facilities is undoubtedly a contributing cause to the normal failure of factory research.

Still again, the University is in possession of large and important consultative facilities—mathematical, physical, engineering, bacteriological, etc.—and these are, of course, freely offered to the chemical researchers working under this system.

Finally, there is about university work, as differentiated from the factory, freedom from interference, correct judgments concerning progress, and an atmosphere sympathetic to research.

All these advantages, laboratory, library, consultative, and inspirational, together with the supervision and administration of these Fellowships, the University offers gratuitously to any company having important problems offering a reasonable chance of solution, and it undertakes, as well, to surround these researches with necessary secrecy.

(*c*) *The Public.*

The public is largely advantaged through this system. No discovery can go to the public as a useful actuality of achievement except through some company, or, to use what in these days, is an invidious term, some *corporation.* Corporations may be good or bad, or both, and the people of this country may be depended upon ultimately to take care that they are made subservient to the public good; but every useful and significant fact is a permanent good to the human race. Even to-day, if manufacturing waste were eliminated and full advantage were taken of significant contemporary discovery, shorter hours of labor would obtain and human need would vanish; in fact, it may be said that never until such a condition does obtain shall we pass out of our materialistic, neurasthenic civilization.

(*d*) *The Researchers.*

For the Fellows, the young men engaged in these researches, the opportunities are unique. If they do not already possess their Ph.D., they may proceed for it in the University, using as their dissertation such portion of their research as we may permit; they are provided with a stipend such as they can show that they deserve; they are given every opportunity for genuine achievement; and, what is more, a full recognition of such achievement; and, finally, if they succeed in a practical way, they are assured through their bonus of a substantial, material reward.

In 1906, on returning from Europe, I proceeded to the University of Kansas, and on January 29, 1907, I established there the first Industrial Fellowship, on the basis of an agreement very similar to that presented above. From that time on I have proceeded carefully and tentatively, learning as I went, to establish one after another of these researches.

In recognition of the progress and demonstrated value of this work as a whole, the University of Kansas two years ago constituted it a department by itself. The University has built almost a dozen laboratory rooms for the accommodation of the Fellows, and in recognition of the value of their instructional services has, through action by the Board of Regents, determined that every Fellow shall in his instructional work receive the titular professorial distinction which his Fellowship stipend warrants. The University has, as well, conferred the degree of Doctor of Philosophy on two of the junior Fellows as a result of their researches. In 1910 the University of Kansas authorized the writer, while retaining his full position in Kansas, to accept, as well, a similar position at the University of Pittsburgh, in order that these Fellowships might be established in the East as well as in the West. The University of Pittsburgh, for the purpose of carrying out the researches, has provided a temporary building, adequately equipped, and has provided the Director with an associate, Raymond F. Bacon, Ph.D., who has charge of the details of the investigations.

A full list of these Fellowships as so far established in both universities, together with the subjects of research, etc., is herewith appended.

UNIVERSITY OF KANSAS FELLOWSHIPS

IN

ORDER OF ACCEPTANCE BY UNIVERSITY OF KANSAS.

Fellowships marked * have been completed.

I. * *Laundering.*
$500 a year for 2 years.
Additional consideration 10 per cent. of net profits.
Fellow: Fred. Faragher, A.B.
January 29, 1907.

II. * *Diastase.*
$500 a year for 2 years (continued 3rd year).
10 per cent. of gross profits.
Fellow: Ralph C. Shuey, B.S. (U. of Kansas).
June 14, 1907.

III. * *Bread.*
$500 a year for 2 years.
Additional consideration.
Fellow: H. A. Kohman, A.B. (U. of Kansas).
April 27, 1908.

IV. * *Casein.*
$500 a year for 2 years.
10 per cent. of net profits.
Fellow: E. L. Tague, A.M.
April 27, 1908.

V. * *Petroleum.*
$1000 a year for 2 years.
10 per cent. of net profits.
Fellow: F. W. Bushong, Ph.D.
April 27, 1908.

VI. * *Enamel.*
$1300 a year for 2 years.
Fellows: A. J. Weith, B.S.
F. P. Brock, B.S.
September 10, 1908.

VII. *Glass.*
$1500 1st year; $1500 2nd year; $1500 3rd year; $1500 4th year.
10 per cent. of net profits.
Fellow: E. Ward Tillotson, Ph.D.
March 9, 1909. (Now in its fourth year.)

VIII. * *Cement.*
$1500 a year for 2 years.
Additional consideration.
Fellow: J. F. MacKey, Ph.D.
March 9, 1909.

IX. *Varnish.*
$1500 1st year; $2700 2nd year; $3900 3rd year.
Additional consideration.
Fellow: 1st year, L. V. Redman, Ph.D.
2d year, L. V. Redman, Ph.D., Senior Fellow,
A. J. Weith, B.S.
F. P. Brock, B.S.
November 10, 1909. (Now in its fourth year.)

X. * *Borax.*
$750 a year for 2 years.
Fellow: B. C. Frichot, B.S.
November 29, 1909.

XI. * *Ductless Glands of Deep-Sea Mammals.*
$1000 a year for 2 years.
Additional consideration.
Fellow: E. R. Weidlein, A.B.
March 1, 1910.

XII. * *Vegetable Ivory.*
$1500 a year for 2 years.
$2000 bonus.
Fellow: J. P. Trickey, A.B. (New Hampshire College).
June 3, 1910.

XIII. *Petroleum.*
$2750 a year for 2 years.
$5000 bonus.
Fellows: F. W. Bushong, Ph.D. (Senior).
J. W. Humphreys, B.S.
April 26, 1911.

XIV. * *Gilsonite.*
$750 a year for 1 year.
$2000 bonus.
Fellow: W. E. Vawter, B.S. (U. of Kansas).
April 26, 1911.

XV. *Fats, Hardening of.*
$1300 a year for 2 years.
49 per cent. interest.
Fellow: E. O. Rhodes (U. of Kansas).
September 19, 1912.

XVI. *Leather-Scrap.*
$1200 a year for 2 years.
10 per cent. interest.
Fellow: R. Phillips Rose, A.B. (U. of Ohio).
October 22, 1912.

XVII. *Copper.*
$1800 a year for 1 year, $500 apparatus fund.
Additional consideration.
Fellow: E. R. Weidlein, A.M.
November 11, 1912.

XVIII. *Copper.*
$1000 a year for 1 year.
Additional consideration.
Fellow: G. A. Bragg, B.S. (U. of Kansas).

UNIVERSITY OF PITTSBURGH FELLOWSHIPS

IN

ORDER OF ACCEPTANCE BY UNIVERSITY OF PITTSBURGH.

I. *Baking.*
$750 a year for 2 years.
Additional cash bonus of $2000.
Fellow: Wilbur A. Hobbs, A.B. (U. of Kansas).
November 30, 1910.

II. *Abatement of the Smoke Nuisance.*
$12,000 1st year; $15,000 2d year.
Additional consideration 49 per cent. collective interest.

Fellows: *Staff in Charge.*

R. C. Benner, Ph.D. (U. of Wis.) (Chief Fellow).
W. W. Strong, Ph.D. (Johns Hopkins), Physicist.
J. A. Beck, LL.B. (U. of Pittsburgh), Attorney.
H. H. Kimball, Ph.D. (Geo. Wash. U.), Meteorologist.
A. B. Bellows, B.S. (Mass. Inst. of Tech.), Engineer.
O. R. McBride, B.S. (Purdue University), Engineer.
A. F. Nesbit, B.S. (Mass. Inst. Tech.), Electrical Engineer.
J. J. O'Connor, Jr., A.B. (U. of Pittsburgh), Economist.
E. H. McClelland, Ph.B. (Lafayette College), Bibliographer.
J. F. Clevenger, M.S. (Ohio State U.), Botanist.
C. H. Marcy, Bacteriologist.
J. E. W. Wallin, Ph.D., Psychologist.

Advisory Staff.

Oskar Klotz, M.D., C.M. (McGill University), Senior Fellow.
E. W. Day, A.M., M.D.
W. C. White, M.D.
R. T. Miller, Jr., M.D.
W. W. Blair, M.D.
B. A. Cohoe, A.B., M.D.
S. R. Haythorn, M.D.
W. L. Holman, M.D.
E. B. Lee, Architect, Senior Fellow.
Richard Hooker, B.S.
C. T. Ingham.

Richard Kiehnel.
Carlton Strong.
K. K. Stevens, B.S.
November 30, 1910; revised, June 24, 1911.

III. *On the Relation of the Pots to Glass in Glass-Making and the Elimination of "Strea."*
$1500 a year for 2 years.
Additional cash bonus of $2000.
Fellow: Samuel R. Scholes, Ph.D. (Yale University).
January 25, 1911.

IV. *Baking* (Wholly Independent of but with Acquiescence of No. I).
$4750 a year for 2 years.
Additional consideration of $10,000.
Fellows: Henry A. Kohman, Ph.D. (U. of Kansas), Senior Fellow.
Charles Hoffman, Ph.D. (Yale University).
Alfred E. Blake, A.B. (New Hampshire College).
January 25, 1911.

V. *Glue.*
$1200 a year for 2 years.
Fellow: Ralph C. Shuey, B.S. (U. of Kansas).
February 3, 1911.

VI. *Soap.*
$1200 a year for 2 years.
Fellow: Paul R. Parmelee, B.S. (U. of Kansas).
February 3, 1911.

VII. *Utilization of Fruit Waste.*
$1000 a year for 2 years.
Additional consideration of $10,000.
Fellow: F. Alexander McDermott (Geo. Wash. University).
May 12, 1911.

VIII. *Composition Flooring.*
$1500 a year for 2 years.
1 per cent. of sales for 5 years.
Fellow: R. R. Shively, B.S. (Okla. A. and M. College).
August 15, 1911.

IX. *Crude Petroleum.*
$10,000 a year for 2 years.
Collective interest of 10 per cent.
Fellows: Benjamin T. Brooks, Ph.D. (U. of Göttingen), Senior Fellow.

Clinton W. Clark, M.A. (Ohio State University).
Lester Pratt, M.S. (New Hampshire College).
Hugh Clark, M.A. (Ohio State University).
Arthur H. Myer, A.M. (Leland Stanford, Jr., University).
Fred. Padgett, B.S. (U. of Pittsburgh).
September 22, 1911.

X. *Natural Gas.*
$4000 a year for 2 years.
5 per cent. of industrial results.
Fellows: R. H. Brownlee, Ph.D. (University of Chicago), Senior Fellow.
Roy Uhlinger, M.A. (U. of Pittsburgh).
September 22, 1911.

XI. *Cement.*
$1800 a year for 2 years.
$10,000 additional consideration.
Fellow: J. F. MacKey, Ph.D. (University of Toronto).
September 22, 1911.

XII. *Foods, Problems Related to the Manufacture of.*
$5000 a year for 2 years.
$10,000 additional consideration.
Fellows: Clarence C. Vogt, Ph.D. (Ohio State University), Senior Fellow.
Harry P. Corliss, B.S. (New Hampshire College).
W. E. Vawter, B.S. (U. of Kansas).
May 20, 1912.

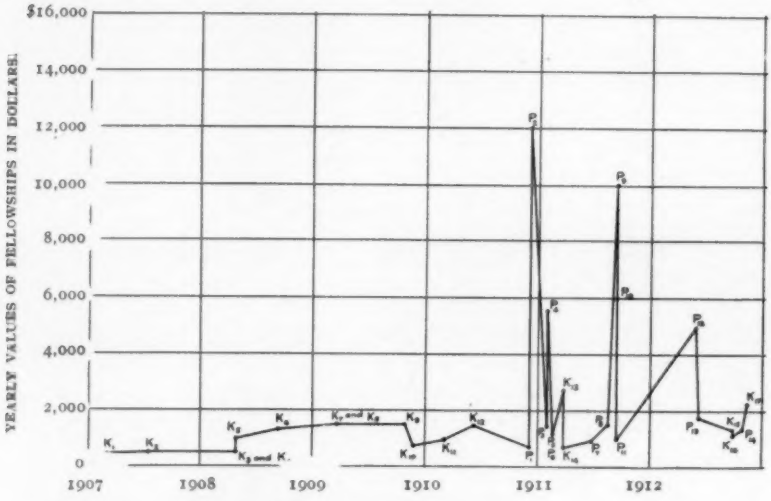
XIII. *Fats and Oils, Bleaching of.*
$1800 a year for 2 years.
Fellow: Leonard M. Liddle, Ph.D. (Yale University).
May 22, 1912.

XIV. *Effect of High Potential Electricity on Chemical Reaction.*
$1000 a year for 2 years; $300 apparatus fund.
Additional consideration.
Fellow not yet appointed.
October 28, 1912.

XV. *Discovery of Methods of Coating Steel or other Metals with Copper or other Metals.*
$1500 a year for 1 year; $500 apparatus fund.
Additional consideration $10,000.
Fellow: C. L. Perkins, B.S. (New Hampshire College).
December 4, 1912.

XVI. *Copper, Extraction of from its Ores and from Copper "Tailings."*
$1500 a year for 1 year.
Teaching Fellow: Howard D. Clayton, B.A. (Ohio State University).
December 1, 1912.

A reading of the list above will make obvious the consistent and accelerated growth of this system, as will the following diagrammatic representation.



DIAGRAMMATIC REPRESENTATION OF THE GROWTH OF THE FELLOWSHIPS IN VALUE.
K refers to the University of Kansas.
P refers to the University of Pittsburgh.

After the system had gotten well under way it became possible and advisable to establish Multiple Fellowships, as differentiated from Individual Fellowships. Multiple Fellowships employ the intensive services of several men under the immediate direction of a Senior Fellow, who is responsible for his juniors to the Director and his Associate. An Individual Fellowship relates to one Fellow only, who is responsible directly to the Associate Director and, through him, to the Director. Such Multiple Fellowships, for example, are K9, K13, P2, P4, P9.

While the time has not as yet arrived in any one case for the publication of results, it may be said that these results on the whole have been most gratifying; indeed, the system could

not have survived, much less grown, except on the basis of progressive success. Quite apart from industrial results involving temporary secrecy, it has been found possible from time to time to publish papers of academic interest; such, for example, are Tillotson's papers on the "Surface Tension of Molten Glass," Weidlein's work on "Adrenalin," or Bushong's paper on "Iso-naphthenic Acids."

From the industrialists themselves we have received a generous, broad-minded trust and co-operation, and the donation of many thousands of dollars' worth of apparatus in recognition of our progress.

The Fellows engaged in these researches, while they have been drawn from many different universities and other sources, have shown a complete understanding of the high trust which they hold and have developed a spirit of mutual helpfulness and an *esprit de corps* that is invariably a subject of favorable comment from visiting colleagues.

During the five years of actual development that this scheme has undergone, any inherent weakness must surely have appeared. It is most gratifying, then, at the conclusion of this paper, to state that none of us engaged in this work is aware of any such weakness. We look forward with confidence to the ultimate establishment of this system of Industrial Fellowships as a permanent relation between Industry and Learning.

November 23, 1912.

Use of Vanadium in Casting German Silver. C. P. KARR. (*Brass World*, viii, II, 392.)—Very perfect castings have been obtained by adding 4 ounces of cupro-nickel-vanadium to the molten bath about 5 minutes before the heat is ready to pour. The cupro-nickel-vanadium, either granulated or broken in small pieces, is wrapped in a piece of paper and dropped in the molten metal, and when it becomes cherry-red is pushed below the surface and held there by an inverted cup-disk, with a handle four feet long. It is held near the bottom of the pot until it is completely absorbed by the charge. Then stir the pot with a pumping motion and allow the charge to remain quiet about 5 minutes, during which the vanadium effects the purification. The vanadium is not deleterious to the crucible. When the metal reaches a clear, limpid condition, shown by its greater mobility, the heat is ready to pour. When the metal is in perfect condition, lambent flames of zinc oxide flare up at the sides.

Dyeing from Different Solvents. J. HÜBNER and H. B. AVERY. (*J. Soc. Dyers and Col.*, xxviii, 280.)—Dyeings made at the ordinary temperature with solutions of Benzopurpurin 10B in mixtures of water and alcohol showed that: (*a*) cotton absorbs less dyestuff from a mixed solvent than from either water or alcohol alone; (*b*) the point of minimum absorption is reached with a mixture of 45 per cent. of water and 55 per cent. of absolute alcohol by volume; (*c*) the cotton absorbs slightly less dyestuff from pure water than from absolute alcohol, and more from alcohol containing 5 per cent. of water than from absolute alcohol. If silk be used instead of cotton, the minimum absorption is reached with the same proportions of alcohol and water, viz., 55:45, and these proportions agree with the composition of the known hydrate of alcohol, C_2H_5OH, $3H_2O$, as shown by Varenne and Godefroy. Different results were obtained with mercerized cotton, the point of minimum absorption being reached with a mixture of 35 per cent. of water and 65 per cent. of alcohol. Methyl alcohol has practically no effect on the absorption of substantive dyestuffs by ordinary cotton, while mercerized cotton absorbs less dyestuff from methyl alcohol than from an aqueous solution. Dyeings from Benzopurpurin 10B in mixtures of water and glycerine showed that the absorption decreases as the proportion of glycerine increases.

Production of Nickel and Cobalt. CH. L. PARSONS. (*Bureau of Mines. "Notes on Mineral Wastes."*)—Nearly all the nickel used in the United States is imported from Canada. Large quantities are known to exist in Idaho, and an immense deposit of a low-grade, hydrous nickel-magnesium silicate lies at Webster, N. C. No economical method of utilizing this low-grade ore has been found. The larger part of the output from the Northwest is now used in the form of monel metal, an alloy of nickel and copper obtained direct from the ore, so the expense of first separating pure nickel has been avoided. Cobalt is almost solely found in imported Canadian silver ores from the famous Cobalt, Ontario, district.

The Aquarelle Process. M. WILCKE. (*Atelier Phot.*, xix, 87.)—This is similar to the gum process, is best suited to large prints, and is highly praised. Paper is coated with celluloid solution, dried, and then coated twice with a solution of 100 c.c. water, 40 Gm. sugar, and 4 Gm. half-hard gelatin, dissolved at not over 45° C. Then a coating of aquarelle color is applied with a brush, and the paper is sensitized in 6 per cent. ammonium bichromate thinned with an equal volume of alcohol. Printing is effected by the actinometer, and the image is developed by warm water sprayed through an atomizer.

NOTES ON THE FORMATION AND INHIBITION OF MILDEW IN PAINTS.[1]

BY

HENRY A. GARDNER,

Assistant Director, The Institute of Industrial Research, Washington, D. C.,
Member of the Institute.

THE formation of mildew upon the surface of green paints such as are used so widely upon the exterior trim and shutters of frame buildings has often been observed by the property owner. In damp localities, especially along the sea coast, the mildewing of painted exterior surfaces is not an uncommon sight, and the painter has searched in vain for materials which would prevent such conditions. A good opportunity was recently afforded the writer to study the subject of mildew, when, during the course of the examination of a red lead paint which had shown a peculiar thickening action, certain types of fungi were discovered. The paint had not hardened up as is usual with pure red lead paints which are kept in containers for a considerable period, but the pigment portion seemed to have no affinity for the oil in which it was ground, a peculiar gelatinous condition being observed. Around the edges of the paint a slight film had formed, and white spots were observed to be present upon the surface of this film. These white spots had the appearance of the type of mould that is often found upon damp basement walls. A portion of the skin was removed and preserved for microscopic examination.

There was obtained a sample of the original linseed oil in which the red lead had been ground, and it was thought advisable to examine this oil as well as the oil floating upon the top of the partially settled pigment, to find out whether both oils were pure. The analysis of the original oil gave the following results, which indicate that it was pure linseed oil:

Color: Light amber with a distinct green fluorescence.
Iodine number 185.2

[1] Communicated by the author.

Acid number	3.4
Ash	.14%

The oil that was poured from the top of the settled red lead pigment had the following constants:

Iodine number	179.1
Acid number	8.8
Ash	2.78%

In the latter analysis the lower iodine value and higher acid number and ash presented differences which could easily be accounted for by the action of the red lead upon the oil. The analyses would therefore indicate that both samples of oil were pure. Curious to state, however, the oil that had been poured from the top of the red lead paint had an odor resembling fish oil, and the use of the latter oil might be held accountable for the condition of the paint. After standing in a bottle for forty-eight hours, the oil became very turbid and viscous, air bubbles having developed throughout the mass. Upon the surface of the oil there had formed a slight film which was covered with very small white spots. A portion of the oil was tested to determine whether there was any large amount of free glycerine present. A small amount was found, suggesting that hydrolysis had taken place. Such hydrolysis, however, might be accounted for by the action of the red lead upon the oil, wherein free fatty acid had been formed, accompanied by the splitting off of glycerine.

A more exhaustive test of the sample to determine whether fish oil was present was made according to the method outlined by Eisenschiml.[2] The original oil and the oil from the top of the can were separately dissolved in a mixture of chloroform and acetic acid and an excess of bromine added to each sample. The test-tubes containing these mixtures were placed in hot water for fifteen minutes. The original oil did not show any precipitated bromides, while the oil from the red lead paint showed a very large quantity. With raw oil, the precipitation of insoluble bromides would constitute a positive test that fish oil was present. It has recently been found, however, that this test is

[2] *Jour. Indus. and Eng. Chem.*, 1910, p. 43.

not of great value when applied to the examination of a boiled linseed oil. Inasmuch as the oil from the top of the red lead paint was shown by analysis to contain over 2 per cent. of lead ash, it might be considered of the same constitution as a boiled oil. Another test, however, which seemed to indicate the presence of fish oil, was made by rubbing a few drops of the oil briskly between the palms of the hands. A very rancid odor was immediately developed. This odor, however, might have been due to the presence of the free fatty acids in the oil, resulting from the hydrolyzing action of the red lead.

At this juncture in the research it was thought that considerable light might be thrown upon the work by a very careful examination to determine the unsaponifiable constituents of the oil. It is well known that in animal oils such as menhaden oil or other fish oils there is present an unsaponifiable constituent termed cholesterol, a crystalline alcoholic body which is entirely absent in vegetable oils such as linseed oil. The latter oil, however, and most other vegetable oils contain a similar unsaponifiable body termed sitosterol. These two bodies are easily differentiated by microscopic examination. Portions of the oils were separately treated with alcohol, the alcoholic extract being saponified and afterwards treated with ether.[3] The ether extract, containing the non-saponifiable bodies, was filtered and evaporated nearly to dryness, being subsequently filtered and then taken up with alcohol. Slow crystallization of the alcoholic solution resulted in the formation of tiny crystals which were examined under the microscope. Both the original oil and the oil used in the manufacture of the red lead paint deposited crystals which when observed under the microscope seemed to be in tufts of star-like groups, probably of a monoclinic system of crystallization (pure sitosterol). These crystals did not in any way resemble the crystals which are known as cholesterol, and the above tests presented pretty conclusive proof that the oil originally used was a pure vegetable oil. A similar test, however, was made with a sample of pure menhaden oil as a blank. After the usual course of treatment, there was obtained a considerable quantity of white crystals which when observed

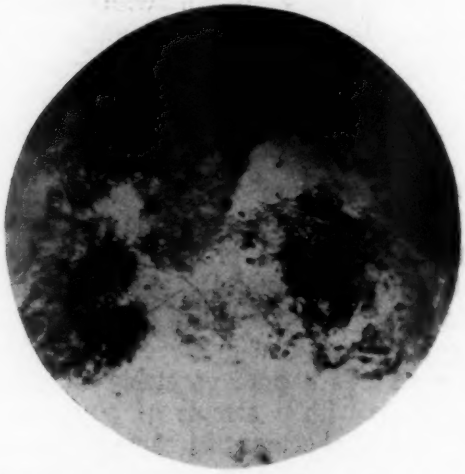
[3] *Jour. Soc. Chem. Indus.*, 17, 954, 1898; "Chemical Technology and Analysis of Oils," etc., Lewkowitsch, vol. i, p. 470; "Oil Analysis," Gill, p. 91.

under the microscope appeared as flat, rhombic plates which are characteristic of the crystals of cholesterol. The melting

FIG. 1.

Crystals of cholesterol extracted from menhaden oil. × 750.

FIG. 2.



Appearance of mould upon dried film of oil. × 750.

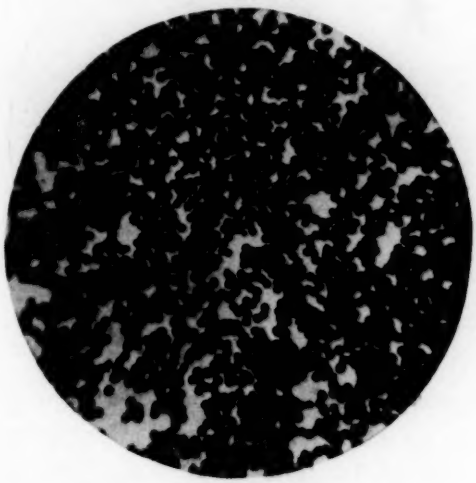
point[4] of the crystals from the linseed oils used in grinding the red lead paint was not determined, the writer being unable

[4] *Jour. Soc. Chem. Indus.*, 1899, 557.

to find present any crystals which had the appearance of those found in the menhaden oil (see Fig. 1).

That the peculiar condition of the red lead paint, previously described, was due to the action of some type of micro-organisms seemed evident. Recourse was therefore had to the examination of what appeared to be mould upon the surface of the red lead paint previous to its chemical examination. A portion of the film upon which the mould had grown was carefully treated with ether to wash away any undried oil. After drying, the film was placed under the microscope. The appearance of the film is shown in Fig. 2. A test-tube culture

FIG. 3.



Culture of spores from linseed oil. × 750.

in agar-agar was made of the mould upon the film. The surface of the agar-agar at the end of twenty-four hours was covered with a greenish mould, while there was shown to have developed downward through the jelly a peculiar white formation. Portions of both growths were examined under the microscope. The white portion was of unicellular structure, as shown in Fig. 3, while the green portion showed distinctly the mycelium with the attached cellular spores (see Fig. 4). These spores and mycelium have the distinct appearance of peniculum crustaceum. The writer is of the opinion spores which are responsible for the mildewing of

paint may exist in nearly all samples of raw linseed oil, as accidental impurities obtained from the exterior of the crushed seed.

The writer has previously found during the course of other experiments, conducted during the past few years, that the use of 5 per cent. of solvent naphtha of 160° benzol, added to the paint previous to application, prevents to a great extent the formation of mildew. On account of the xylol and toluol con-

FIG. 4.

Peniculum crustaceum growing upon linseed oil. Film × 750.

tent of solvent naphtha, both of these constituents having high boiling points, they are retained in the drying film and they serve to inhibit the formation of the fungus. Another material which might serve the same purpose is refined pine oil, a water white product of very high boiling point, resulting from the distillation of turpentine. Both solvent naphtha and pine oil have excellent penetrative properties and when used in an exterior paint serve to carry the pigment into the fibres of the wood to produce a firm foundation coat.

NOTES FROM THE U. S. BUREAU OF STANDARDS.

THE ACTION OF THE SALTS IN ALKALI WATER AND SEA WATER UPON CEMENTS.[1]

By P. H. BATES, Ceramic Chemist; A. J. PHILLIPS, Assistant Chemist; RUDOLPH J. WIG, Associate Engineer Physicist.

THE paper describes a series of laboratory and field investigations made to determine the suitability and permanency of various cements in structures exposed to the chemical and mechanical action of the salts present in sea water and alkali water. The laboratory investigations consisted in subjecting various typical cements to salt solutions for a period of months, the solutions being renewed from time to time and their action noted by analyzing the solutions as removed and the residue at the end of the test. Small hollow cylinders of cement and cement mortar were made and exposed to the percolation of various salt solutions. Field investigations were made by exposing cements in the form of briquettes and concrete test pieces to sea water at a branch laboratory established at Atlantic City, N. J. The conclusions, as stated in the paper, are limited by the scope of investigation, and since the physical tests cover a period of exposure not exceeding two years, the conclusions are considered tentative.

1. Portland cement mortar or concrete if porous can be disintegrated by the mechanical force exerted by the crystallization of any salt in its pores if a sufficient quantity is permitted to accumulate, and the rapid formation of crystals is brought about by drying, and as larger crystals are formed by slow crystallization there will be obtained the same results on a larger scale but in a greater time if slow drying were had. Porous stone, brick, and other structural materials may be disintegrated in the same manner. Therefore, in alkali regions where a concentration of salts is possible a dense non-porous surface is essential.

2. While in the laboratory a hydraulic cement is rapidly decomposed if intimately exposed to the chemical action of

[1] Abstract of Technologic Paper No. 12.

various sulphate and chloride solutions, field inspection indicates that in service these reactions are much retarded if not entirely suspended in most cases, due probably to the carbonization of the lime of the cement near the surface or the formation of an impervious skin or protective coating by saline deposits.

3. Properly-made Portland cement concrete when totally immersed is apparently not subject to decomposition by the chemical action of sea water.

4. While the tests indicate that Portland cement concrete exposed between tides resisted chemical decomposition as satisfactorily as the totally immersed concrete, it is felt that actual service conditions were not reproduced, and therefore further investigation is desirable.

5. It is not yet possible to state whether the resistance of cements to chemical disintegration by sea water is due to the superficial formation of an impervious skin or coating which is subsequently assisted by the deposition of shells and moss, forming a protective coating, or by the chemical reaction of the sea salts with the cement, forming a more stable compound without disintegration of the concrete, or by a combination of both of these phenomena.

6. Marine construction, in so far as the concrete placed below the surface of the water is concerned, would appear to be a problem of method rather than materials, as the concrete sets and permanently hardens as satisfactorily in sea water as in fresh water or in the atmosphere, if it can be placed in the forms without undue exposure to the sea water while being deposited.

7. Natural, slag, and other special cements tested in concrete mixtures showed normal increase in strength with age both in sea water and in fresh water.

8. In the form of neat briquettes most of the cements of high iron content, and several of the cements of high or normal alumina content, did not show any marked difference in tensile strength whether exposed to fresh or sea water for all periods up to one year. Other cements of various composition showed signs of disintegration after a few weeks.

9. All cements resisted disintegration in sea water better in mortar mixtures than in the form of neat briquettes.

10. The physical qualities of the cement, which depend

essentially upon the method of manufacture, would seem to determine its resistance to decomposition when brought into intimate contact with the sulphate and chloride solutions.

11. Contrary to the opinion of many, there is no apparent relation between the chemical composition of a cement and the rapidity with which it reacts with sea water when brought into intimate contact.

12. Tricalcium-sulpho-aluminate could not be formed, and therefore disintegration could not result from this cause.

13. In the presence of sea water or similar sulphate chloride solutions:

(*a*) The most soluble element of the cement is the lime. If the lime of the cement is carbonated it is practically insoluble.

(*b*) The quantity of alumina, iron, or silica present in the cement does not affect its solubility.

(*c*) The magnesia present in the cement is practically inert.

(*d*) The quantity of SO_3 present in the cement up to 1.75 does not affect its solubility, but a variation in the quantity present may affect its stability by affecting its rate of hardening.

14. The change which takes place in sea water when brought into intimate contact with the cement is as follows:

(*a*) The magnesia is precipitated from the sea water in direct proportion to the solubility of the lime of the cement.

(*b*) The sulphates are the most active constituents of the sea water, and are taken up by the cement. Their action is accelerated in the presence of chlorides. No definite sulphate compound was established.

(*c*) The quantity of chlorine and sodium taken up by the cement is so small that no statement can be made as to the existence of any definite chloride or sodium compound formed with the cement.

15. The SO_3 added to a cement in the plaster to regulate the time of set is chemically fixed so that it will not go into solution when the cement is brought into intimate contact with distilled water.

16. Metal reinforcement is not subject to corrosion if imbedded to a depth of 2 inches or more from the surface of well-made concrete.

THE DIFFUSE REFLECTING POWER OF VARIOUS SUBSTANCES.

BY

W. W. COBLENTZ, Ph.D.,

Associate Physicist, U. S. Bureau of Standards.

Corrected Table.*

TABLE I.

REFLECTING POWER OF LAMPBLACK.

Wave-length. λ max.	.54μ	.60μ	.95μ	.95μ (red glass)	4.4μ	8.8μ	24.μ
	%	%	%	%	%	%	%
Silver	93.2	89.9	93.4	94.6	98.0	98.0	98.5
Aluminum		68.5			92.3		
Correction factor	1.102	1.143	1.100	1.086	1.049	1.049	1.043
Lampblack Paint		2.94			3.24		
		3.02			2.29		
		3.58			3.60	Alcohol + shellac.	
		3.72			4.86		
		3.10	3.38	3.36	3.34	3.75	4.4
Paraffin candle (hot)			0.97				
(Cold soot)		1.07–1.43					
Rosin			1.26		1.31		
					.85	1.07	2.8
Sperm candle			.91		.67	1.44	3.9
			1.02		.93	1.27	4.1
			1.25		1.03		
			1.07		.77	1.28	
			1.01		1.36	1.23	
					1.28	.87	
Camphor			1.34		1.38	1.46	
			1.30		.95	1.65	5.7
			1.36		1.15		
(Paint)			2.80		3.24		
Acetylene			.59				
			.82		.92	1.12	3.0
			.64		.71	1.24	
			.54		.81		
			.42		.71		
(Cold deposit)			.86				
(No air)			1.33				

* See article November, 1912, vol. clxxiv, p. 564.

THE FRANKLIN INSTITUTE

(Proceedings of the Stated Meeting held Wednesday, December 18, 1912.)

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, December 18, 1912.

PRESIDENT WALTON CLARK *in the Chair.*

Additions to membership since last report, 55.

The following nominations were made for officers and managers to be voted for at the annual election held January 15, 1913:

For President (to serve one year), Walton Clark.

For Vice-President (to serve three years), Henry Howson.

For Treasurer (to serve one year), Cyrus Borgner.

For Managers (to serve three years), Francis T. Chambers, W. C. L. Eglin, Alfred C. Harrison, Charles A. Hexamer, Robert W. Lesley, Robert S. Perry, E. H. Sanborn.

The Chairman then introduced Dr. Isham Randolph, Consulting Engineer, of Chicago, who presented the paper of the evening, entitled "The Engineer in the Building of the Republic."

The development and progress of transportation by means of canals and railroads was reviewed, and the achievements of the engineer in the construction of bridges, dams, reclamation and irrigation plants were enumerated. Interesting information was presented relating to the growth of the railroads of the United States, their trackage, siding, etc., and the increase in the horsepower of locomotives since their first introduction. Reference was made to many notable engineering projects, including the Panama Canal, the Roosevelt Dam, the Chicago Drainage Canal, the hydro-electric plants at Niagara Falls and elsewhere, and the problem of supplying large cities with water.

On motion of Mr. Dodge, duly seconded, the thanks of the meeting were extended to Dr. Randolph.

Adjourned.

R. B. OWENS,
Secretary.

COMMITTEE ON SCIENCE AND THE ARTS.

(Abstract of Proceedings of the Stated Meeting held Wednesday, December 4, 1912.)

HALL OF THE FRANKLIN INSTITUTE,
PHILADELPHIA, December 4, 1912.

DR. GEORGE A. HOADLEY *in the Chair.*

The following report was presented for final action:

No. 2499.—Santo Vacuum Cleaner. Advisory. Adopted.

The following reports were presented for first reading:

No. 2512.—Rosanoff's Methods of Determining Partial Vapor Pressures. Advisory. Adopted.

No. 2518.—Hopkins' Thermal Indicator.

No. 2521.—Hoover Suction Sweeper. Advisory. Adopted.

The following was accepted for examination:

No. 2522.—Gaede's Molecular Air Pump.

R. B. OWENS,
Secretary.

SECTIONS.

Mechanical and Engineering Section.—A meeting of the section was held on Thursday evening, December 5, 1912, in the Hall of the Institute, at 8 o'clock. This was a joint meeting of the section and the Philadelphia Section of the American Institute of Electrical Engineers.

The meeting was called to order by the Chairman, Mr. George R. Henderson. The reading of the minutes of the previous meeting was dispensed with, and, after a few introductory remarks, the Chairman introduced Mr. H. T. Herr, Vice-President and General Manager of the Westinghouse Machine Company, who read a paper on "Recent Advances in the Steam Turbine Art." The paper was illustrated by numerous lantern slides, and the speaker brought out very clearly the characteristics of the different types of steam turbines and their advantages and disadvantages.

The paper was followed by a few remarks by Mr. Henderson and a short discussion by Professor Lanza and Mr. J. A. P. Crisfield, after which a vote of thanks was tendered Mr. Herr and the meeting adjourned.

FRANK B. STEM,
Secretary.

Section of Physics and Chemistry.—A meeting of the section was held in the Hall of the Institute, on Thursday, December 12, 1912, at 8 P.M.

Dr. Harry F. Keller occupied the Chair.

With a few introductory remarks, the Chairman introduced Dr. Wilder D. Bancroft, Professor of Physical Chemistry at Cornell University, Ithaca, N. Y.

Dr. Bancroft gave an interesting and entertaining lecture on "Chemiluminescence."

After explaining the meaning of the term, he went on to show how, in the light of present knowledge, it might well be applied to all forms of luminescence, such as photo-luminescence, cathodo-, anodo-, electro-, pyro-, etc.

He gave demonstrations to show that, in the chemical production of light, the intensity of light produced was a function of the velocity of reaction.

He spoke of the light of the firefly as being undoubtedly of chemical

nature and said that this light could be duplicated if a chemical reaction could be discovered which took place with sufficient velocity but at the same low temperature.

The thanks of the meeting were extended to Dr. Bancroft.

Adjourned.

WM. E. BULLOCK,
Acting Secretary.

MEMBERSHIP NOTES.

Elections to Membership.

RESIDENT.

MR. WALTER R. ADDICKS, No. 4 Irving Place, New York, N. Y.
MR. HENRY D. BOOTH, Midvale Steel Company, Philadelphia, Pa.
MR. NEWLIN T. BOOTH, Pennsylvania Steel Castings and Machine Company, Chester, Pa.
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MR. JAMES H. WYATT, Cutler Electric and Manufacturing Company, corner Nineteenth and Hamilton Streets, Philadelphia, Pa.

NON-RESIDENT.

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MR. C. E. POSTLETHWAITE, Manager of Sales, Pressed Steel Car Company, Pittsburgh, Pa.

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MR. J. T. WALLIS, Superintendent Motive Power, Pennsylvania Railroad Company, Altoona, Pa.

MR. GEO. B. WELLINGTON, 17 First Street, Troy, N. Y.

Changes of Address.

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MR. FRANKLIN BAKER, JR., corner Wayne Avenue and Hortter Street, Germantown, Philadelphia, Pa.
MR. J. B. BAKER, Thirty-second and Powelton Avenue, Philadelphia, Pa.
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PROF. JAMES C. BIDDLE, JR., Abbey of Gethsemani, Trappist P. O., Ky.
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MR. WM. A. DOBLE, Nineteenth and Harrison Streets, San Francisco, Cal.
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MR. WM. J. DOYLE, 1519 Sansom Street, Philadelphia, Pa.
MARY C. DUBOIS, 1733 Pine Street, Philadelphia, Pa.
MR. J. H. EASTWICK, 2260 North Fifty-third Street, Philadelphia, Pa.
MR. WM. P. EVANS, 500 North Fifteenth Street, Philadelphia, Pa.
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MR. SIMON I. KOHN, 720 Market Street, Philadelphia, Pa.
MR. G. C. LEIDY, Whitehall Hotel, 107th Street, Cleveland, Ohio.
MR. E. F. MASON, University Club, Altoona, Pa.
MR. JAMES HARTLEY MERRICK, Roxborough, Philadelphia, Pa.
MR. WM. H. MERRICK, Schoolhouse Lane, Germantown, Philadelphia, Pa.
MR. HENRY F. MITCHELL, Thirty-sixth and Reed Streets, Philadelphia, Pa.
MR. LOUIS M. PAWLETT, 231 Fairfield Avenue, Bridgeport, Conn.
MR. KURT W. PEUCKERT, Sharon Hill, Delaware County, Pa.
MR. JOHN T. RAMSDEN, 1911 North Seventeenth Street, Philadelphia, Pa.
MR. JESSE W. RENO, 684 St. Nicholas Avenue, New York, N. Y.
MR. EDWARD ROWLAND, W. & H. Rowland, Inc., Frankford, Philadelphia, Pa.
MR. J. B. RUMBOUGH, P. O. Box 912, Asheville, N. C.
MR. SAMUEL SHOEMAKER, 1831 Land Title Building, Philadelphia, Pa.
MR. ARTHUR H. THOMAS, West Washington Square, Philadelphia, Pa.
MRS. F. VON A. CABEEN, New Britain, Bucks County, Pa.
MR. ALOIS VON ISAKOVICS, Synfleur Scientific Laboratories, Monticello, N. Y.
MR. GEORGE VON UTASSY, 381 Fourth Avenue, New York, N. Y.
MR. FRANCIS R. WELSH, 109 South Fourth Street, Philadelphia, Pa.
MR. JOHN R. WIGGINS, 1215 Filbert Street, Philadelphia, Pa.
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MR. JOHN JACOB WOLF, 927 North Fifth Street, Philadelphia, Pa.
MR. ASA W. WHITNEY, 500 Georgia Avenue, Bristol, Tenn.
DR. FRANCIS WYATT, 20 Fifth Avenue, New York, N. Y.
LIEUT. A. B. WYCKOFF, 131 East H Street, Ontario, Cal.

NECROLOGY.

William Laws Boswell was born in Philadelphia on June 22, 1828. He was educated in the public and private schools, and finally attended the University of Pennsylvania, where he was graduated in 1848. Later, he became an instructor in Dickinson College, after which he was ordained to the ministry, and was a member of the Philadelphia Methodist Episcopal Conference three years. He finally became an insurance broker, in which business he continued to 1904.

Mr. Boswell was a trustee of Dickinson College. He was elected to membership in the Institute in 1872, and became a life member ten years later.

Mr. George Burnham, 3401 Powelton Avenue, Philadelphia, Pa.
Mr. F. F. Milne, 1714 Spruce Street, Philadelphia, Pa.

LIBRARY NOTES.

Purchases.

American Institute of Chemical Engineers, Transactions, vol. iv, 1912.
BOOTH, W. H., and J. B. C. KERSHAW.—Smoke Prevention. 1906.
BOYLE, R., and E. H. AMAGAT.—The Laws of Gases. 1899.
BUCHANAN, J. F.—Practical Alloying. 1910.
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Gifts.

American Blower Company, Catalogue of Products. Detroit, no date. (From the Company.)
American Railway Master Mechanics' Association, Proceedings, vol. xlv, 1912. Chicago, 1912. (From the Association.)
American Rolling Mill Company, Methods for the Analysis of Iron and Steel used in their Laboratories. Middletown, Ohio, 1912. (From the Company.)
Amsterdam Royal Academy of Sciences, Year Book for 1911 and Proceedings of the Section of Science. Amsterdam, 1911–12. (From the Academy.)
Baylor University, Annual Report of the President and Trustees, October, 1912. Waco, Tex., no date. (From the University.)
Chicago, Department of Smoke Inspection, Report for February, 1911, and February, 1912. Chicago, 1911–12. (From the Department.)
Cooper (C. and G.) Company, Catalogue of Cooper Gas Engines. Mount Vernon, Ohio, 1912. (From the Company.)
Great Britain, Board of Trade, Report on Changes in Rates of Wages and Hours of Labour in the United Kingdom, 1911. London, 1911. (From the Department of Labour.)
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Institution of Mining and Metallurgy, Transactions 21st Session, 1911–12, vol. xxi. London, 1912. (From the Institution.)
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Isthmian Canal Commission, Report on the Panama Canal Traffic and Tolls, by Emory R. Johnson. Washington, D. C., 1912. (From Mr. E. R. Johnson.)

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Murphy Iron Works, Catalogue of the Murphy Automatic Furnace. Detroit, no date. (From the Works.)

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Neptune Motor Company, Catalogue of Trident Water Meters. New York, 1912. (From the Company.)

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Palmer, Truman G., Sugar at a Glance. Charts and Data. Washington, D. C., 1912. (From the Hon. H. C. Lodge.)

Permanent International Association of Navigation Congress, 12th Congress, Philadelphia, Pa., 1912. 1st Section, Inland Navigation, 2d Section, Ocean Navigation. Philadelphia, no date. (From Mr. James Donald.)

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Triumph Electric Company, Bulletin for August, 1910, to August, 1912. Cincinnati, no date. (From the Company.)

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White (S. S.) Dental Manufacturing Company, Catalogues of Products. Philadelphia, no date. (From the Company.)

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Yale University, Astronomical Observatory, Transactions vol. ii, parts 3 and 4. New Haven, 1911. (From the Observatory.)

PUBLICATIONS RECEIVED.

La Théorie des Ions et l'Électrolyse par Auguste Hollard. Deuxième édition, entièrement refondue. 220 pages, illustrations, 8vo. Paris, Gauthier-Villars, 1912. Price, 5 francs.

Smoley's Tables. Parallel tables of logarithms and squares. Diagram for solving right triangles. Angles and logarithmic functions corresponding to given levels. Common logarithms of numbers. Tables of logarithms and natural trigonometric functions and other tables for engineers, architects, and students, by Constantine Smoley, C.E. Seventh edition, revised and enlarged. 329 + 174 pages, 12mo. New York, McGraw-Hill Book Company, 1912. Price, in leather, $3.50.

Engineering of Shops and Factories, by Henry Grattan Tyrrell, C.E. 399 pages, illustrations, 8vo. New York, McGraw-Hill Book Company, 1912. Price, in cloth, $4.

North Carolina Geological Survey: Economic Paper No. 27, Highway Work in North Carolina, containing a statistical report of road work during 1911, by Joseph Hyde Pratt, State Geologist, and Miss H. M. Berry, Secretary. 145 pages, illustrations, plates, maps, 8vo. Raleigh, State Printers, 1912.

National Association of Cotton Manufacturers. Transactions No. 92, Annual Meeting, April 24–25, 1912. 452 pages, illustrations, plates, 8vo. Boston, Association, 1912.

Annuaire pour l'an 1913 publié par le Bureau des Longitudes, Avec des notices scientifiques. 883 pages, illustrations, 16mo. Paris, Gauthier-Villars, no date. Price, in paper, 1 franc 50c.

U. S. Department of Agriculture: Forest Service. Bulletin 113, Methods and Apparatus for the Prevention and Control of Forest Fires, as Exemplified on the Arkansas National Forest, by Daniel W. Adams, Forest Examiner. 27 pages, illustrations, 8vo. Bulletin 117, Forest Fires: Their Causes, Extent, and Effects, with a summary of recorded destruction and loss, by Fred. G. Plummer, geographer. 39 pages, illustrations, 8vo. Washington, Government Printing Office, 1912.

U. S. Bureau of Mines: Bulletin 46, An Investigation of Explosion-proof Motors, by H. H. Clark. 44 pages, illustrations, plates, 8vo. Technical Paper 25, Methods for the Determination of Water in Petroleum and its Products, by Irving C. Allen and Walter A. Jacobs. 13 pages, illustrations, 8vo. Technical Paper 27, Monthly Statement of Coal-mine Accidents in the United States, January to August, 1912, and Statistics for

1910 and 1911, compiled by Frederick W. Horton. 24 pages, 8vo. Washington, Government Printing Office, 1912.

A Study of Trolley Light Freight Service and Philadelphia Markets in their Bearing on the Cost of Farm Produce, by Clyde Lyndon King, Ph.D., Wharton School of Finance and Commerce, University of Pennsylvania, made under direction of Rudolph Blankenburg, Mayor, Philadelphia. 58 pages, map, 8vo. Philadelphia, Department of Public Works, October, 1912.

Canada, Department of Mines, Mines Branch: Production of Cement, Lime, Clay Products, Stone, and Other Structural Materials in Canada during the Calendar Year 1911. John McLeish, B.A., Chief of the Division of Mineral Resources and Statistics. 55 pages, 8vo. Production of Iron and Steel in Canada during the Calendar Year 1911. John McLeish, Chief of the Division of Mineral Resources and Statistics. 32 pages, 8vo. Ottawa, Government Printing Bureau, 1912.

Philadelphia Bureau of Water: Water Supply Educational Series Bulletin No. 2, A Study in Industrial Water Charges. 48 pages, 8vo. Philadelphia, Bureau of Water, November, 1912.

Idioma Auxiliar Internacional, Historia de la delegacion para su adopcion por Claro C. Dassen, Ingeniero Civil, Doctor en ciencias fisico-mathematicas. 51 pages, 16mo. Buenos Aires, Jose Cuneo, 1911.

BOOK NOTICE.

ANALYSIS OF METALLURGICAL AND ENGINEERING METHODS, by Henry Wysor, B.S., Assistant Professor of Analytical Chemistry and Metallurgy in Lafayette College, Pa. The Chemical Publishing Company, Easton, Pa., 1912, $2.00.

This is a student's text-book, or manual, intended for beginners in quantitative analysis, as well as for advanced workers, containing an introductory chapter in which many principles are generalized.

The table of contents shows that it covers methods of sampling ores, analyzing limestone, Portland cement, coal and coke, iron ores, copper ores and matte, lead ores and furnace products, zinc ores; analyses of iron, alloy steels, ferro-manganese and iron rich in manganese, brass and bronze, soft bearing metal; analysis of water; analysis of producer gas; calorimetry of coal, coke, oil and gases; examination of lubricating oil; examination of the micro-structure of iron and steel; heat treatment of metals; tables of atomic weights and bibliography, etc.

This is an extensive field to be covered in a book having 73 pages of printed matter and 9 pages of cuts.

It is needless to say that there is no overelaboration under these limitations. On the contrary, there are some omissions. For example: Under the heading of "Analysis of Iron" the method of "determination of silicon in pig iron and high silicon iron" is condensed into the space of five and a half lines.

The method given is the very well known rapid one, but this is *not* applicable to pig iron *high* in silicon, for the reason that such iron will not dissolve in the solvents named, a mixture of sulphuric and nitric acids. An entirely different method of treatment is necessary where silicon is present in considerable proportion. The nickel crucible generally used in the analysis of ferro-silicon is not mentioned at all in the book, nor is any method given for analyzing ferro-silicon, an omission that is more remarkable from the fact that a page is devoted to the analysis of ferro-manganese and iron rich in manganese.

Another strange omission noted is the total absence of an index, while the table of contents gives no reference to pages and the book is not arranged in chapters.

Alternate pages are left blank for insertion of notes by the student, and the book will doubtless be found useful in connection with a teacher's instructions.

The book is claimed to be "a systematic arrangement of laboratory methods," and this claim appears to be substantiated upon examination.

Methods for determination of vanadium, titanium, chromium, and tungsten in iron are given in a few very brief paragraphs, and as these elements in alloy steels have assumed great importance in recent years a more extended description of the best analytical methods, with a statement of the precautions necessary to avoid errors, would seem to be advisable in order to enhance the permanent value of the book and to extend its usefulness beyond the immediate range of the author's classes.

A. E. OUTERBRIDGE, JR.

CURRENT TOPICS

After-Luminosity of Electric Discharge in Hydrogen. R. J. STRUTT. (*Roy. Soc. Proc., Ser. A,* lxxxvi, 529.)—Hertz described a phenomenon of after-luminosity which he observed in hydrogen on passing a series of jar discharges through a small discharge tube with an open end, arranged inside a bell-jar. It was observed that at each discharge a steam of luminous gas was ejected from the end of the small discharge tube into the bell-jar. He sometimes observed a jet of blue luminosity, which was best developed at a pressure of 100 mm., and considered he had good evidence that this luminosity showed the hydrogen spectrum, but he found an unaccountable capriciousness of the effect, which sometimes did not appear at all. He failed to trace the cause of this uncertainty. Goldstein made similar experiments; he says that the spectrum consists of at least 10 bands, from the green to the ultra-violet, totally unrelated to the hydrogen spectrum. But he believed the glow was due to pure hydrogen. With the same apparatus the spectrum of the glow is now obtained, and is found identical with that of active nitrogen passed over heated sulphur. The blue glow in hydrogen, then, is connected with the presence of sulphur as an impurity in the gas. On cooling in liquid air an annex of the vessel in which the glow is observed, so as to condense hydrogen sulphide (or any sulphur compound), the glow disappears in one or two minutes. On removing the liquid air, and allowing the glass to warm up, it is restored to its full brilliancy.

Diesel Engines. ANON. (*Amer. Mach.,* xxxvii, 4, 149.)—The increase in size of the Diesel engine is noteworthy. Engines of some hundreds of horsepower have become common in Europe. in Swiss electric stations Diesel engine units of 2000 horsepower are now in use, and it is said that the development of the large-sized Diesel engine has been so successful that before long it will not be deemed extraordinary to develop 1000 horsepower in one cylinder. One company of world-wide reputation is considering over 2000 horsepower in the single cylinder of Diesel engines. Engines of this type with four cylinders developing 1000 horsepower each can be made as light as the corresponding triple-expansion steam engine. The weight of such engines compares favorably with that of the corresponding turbines and boilers. A 1000-horsepower installation of this type weighed only 187 pounds per horsepower, as compared with 180 pounds for a steam turbine and boiler installation.

The International Photometric Commission, commonly known as the "Zurich Commission," was created by the International Congress of Gas Industries which convened in Paris in 1900. This Commission, composed of representatives from the various national technical gas societies, with the co-operation of certain of the national laboratories, has been concerned with general questions of photometry in addition to its more specific functions in connection with the photometry of the incandescent mantle.

Inasmuch as there has developed a widespread appreciation of the need of an international, thoroughly representative commission to deal with general questions of photometry, and possibly also of illumination, it has been proposed that the International Photometric Commission be reorganized to fulfil these requirements in a way acceptable to all photometric interests This movement is being well received both in Europe and America.

President Vautier of the International Photometric Commission has requested the Sub-Commission on Photometric Units and Standards to formulate a plan of reorganization. This Sub-Commission was originally appointed at the 1911 session of the International Photometric Commission to consider the recommendations of the Illuminating Engineering Society (U. S.) regarding photometric nomenclature and standards. The Sub-Commission at present is composed of the following members: Dr. Brodhun, Dr. Kusminsky, M. F. Laporte, Mr. C. C. Paterson, Secretary, M. Th. Vautier, Ex-Officio, and a representative of the United States soon to be appointed. The personnel of the Sub-Commission, composed of representatives of the various national laboratories, is peculiarly qualified to undertake the duty of formulating plans of reorganization. It is hoped that as the outcome of the efforts of the Sub-Commission, with the endorsement of the various national technical gas societies to which the International Photometric Commission in the past has been responsible, an essentially new Commission will be formed which will be equally representative of and responsible to all national technical gas, electric and illuminating engineering societies, and other bodies interested in photometry and illumination.

Velocity of Secondary Rays Liberated by Canal Rays. H. BAERWALD. (*Deutsch. Phys. Gesell. Verh.*, xiv, 675.)—The velocity of secondary rays liberated from solid substances by canal rays has been found by C. Füchtbauer to be 30 volts, while Lenard has shown that secondary rays due to cathode rays have only 10.8 volts velocity. In the present experiments the velocity of the secondary rays set free from solid bodies by the canal rays is found to be of the same order of magnitude as those liberated from solids by cathode rays. This indicates similarity in the mechanism of procedure in the two cases. Further experiments are being undertaken.

Heat of Evaporation of Liquid Air. G. WITT. (*Ark. för Mat. Astron. och Fysik,* vii, 32.)—The liquid air was contained in a Dewar vessel, and a known amount of heat was added by passing an electric current through a resistance immersed in the liquid. The amount of liquid evaporated was determined by measuring the volume of air expelled; and blank experiments were made to determine the rate of evaporation when no heat is applied. Since the latent heat of vaporization varies with the composition of the liquid air, this composition must be determined. This was effected by measuring the temperature of the liquid during the experiments by means of a thermo-junction and calculating the composition from the boiling point by means of Baly's measurements. The latent heat, L, in Gm. calories is given by the equation $L = 49.59 + 0.0143\ p$, where p is the percentage of oxygen in the liquid air. The latent heats of nitrogen and oxygen are therefore 49.59 and 51.92 Gm. calories respectively. By the application of Clapeyron's equation to the experimental results obtained by other observers for the boiling point, difference in specific volumes of the liquid and gas, and alteration of the boiling point with the pressure of pure nitrogen and oxygen, the latent heats are calculated to be 48.9 and 51.4 Gm. calories respectively, which values agree well with the author's experimental results.

Cassegrain Telescope Mounting. E. SCHAER. (*Archives des Sciences,* xxxiii, 201.)—After some remarks on the adjustment of telescopes in general, there is given a description of the construction of a large Cassegrain reflector for the Observatory of Geneva during 1909–1910. The focal length is 295 cm.; the diameter of the large mirror is 100 cm.; the equivalent focal length is 1760 cm. The equatorial movement is controlled by an oil clepsydra driven by a 60 kg. weight. At the ocular end fittings are provided for photographic plates of 13 x 18 cm. Several photographs are reproduced showing the satisfactory performance of the instrument.

Gapless, Granular, Three-color Screens for Color Photography. J. BAMBER. (*Eng. Pat.* 15, 755, July 7, 1911.)—A suitable support, such as glass or celluloid, is coated with a layer of varnish consisting of 1 part gum sandarach, 1 part castor oil, 2 parts lavender oil, and 4 parts alcohol; while this is still adhesive the color grains are applied to it in a thin layer. These are prepared by coloring with suitable dyes the grains obtained from a mixture of 4 parts gum sandarach, 1¼ parts castor oil, and 12 parts of alcohol. By using these mixtures the color grains absorb the oil from the varnish and become permanently plastic. The screen is now subjected to the action of a solvent vapor, *e.g.*, alcohol, wood-naphtha, or acetone, and allowed to dry. The grains momentarily dissolve and the solvent evaporates so rapidly that the grains form a continuous layer, but the colors do not intermingle.

Conversion of Nitrogen into its Compounds. J. A. A. AUZIES. (*Rev. Gen. Chim. fur. appli.*, xv, 233.)—After consideration of the known methods of oxidizing atmospheric nitrogen, it is deduced from theoretical reasoning that the yield is improved 25 per cent. by the use of a gas current of 50 per cent. nitrogen and 50 per cent. oxygen. Tables illustrate the relation between temperature and yield. The oxidation of nitrogen has been effected by the use of catalysts, apparently by the formation of unstable peroxides which yield active oxygen. These catalysts are obtained by the calcination of the hydroxides of cobalt, magnesium, chromium, nickel, platinum, palladium, barium, lead, cerium, and thorium. The best results are obtained with thorium oxide or mixtures containing it. The 50 per cent. mixture of gases is obtained by enriching air with oxygen produced as a by-product in the manufacture of nitrogen by fractional distillation of liquid air. The gas current is dried and then passed over plates on which the catalyst is spread in thin layers, which are heated to a suitable temperature. The further oxidation of nitric oxide to peroxide is effected in chambers at 150° C., and is accelerated by the influence of ultra-violet radiation. The yield is improved when the pressure in the chamber is raised to about 5 atmospheres. The products of the reaction are passed into a receiver cooled in liquid air, which retains the nitrogen peroxide and allows the nitrogen and oxygen to pass back again through the apparatus. For the preparation of ammonia from nitrogen by catalysis with nickel, iron, cobalt, boron, titanium, aluminum, etc., it is essential that the nitrogen and hydrogen should be absolutely free from oxygen, and the mixture is first passed through a solution of chromous sulphate. The catalyst is generally prepared by soaking raw cotton in a solution of a salt of the metal, then in solution of ammonia and igniting. Only those metals, the oxides of which are not reducible by hydrogen, must be used in the powdered condition. The gas current is passed over the catalyst in tubes which are heated red hot in metal baths, and the product of the reaction is quickly cooled below 500° C. As examples of the proportions for mixing the catalysts, these are suggested: 22 parts of boron, or 55 parts of aluminum to 168 parts of reduced nickel. The formation of ammonia is due to the preliminary production of an unstable boron nitride and the activation of the hydrogen by the reduced nickel.

Retardation of the β-Rays in Their Passage through Matter. O. V. BAEYER. (*Physik. Zeit.*, xiii, 485.)—The penetrating β-rays of thorium A, after passing through very thin foils of aluminum, tin, copper, or platinum, show a somewhat greater deviation in the magnetic field than the incident rays; therefore it is concluded that the β-rays are slowed down somewhat in their passage through matter. The retardation in copper tin, and platinum is less than in equivalent thickness of aluminum, but the absorption is greater.

Durobax: A New Glass for Gauge Glasses. H. THIENE. (*Zeitschr. Instrumentenk. Beib.*, xvi, 165.)—The desirable qualities of a boiler gauge-glass are: strength to resist pressure, insensitiveness to boiler fluctuations, and immunity to chemical action of steam or feed-water. Practically all gauge-glasses will stand 200 to 300 atmospheres in the cold state. Heated up to boiler temperature and sprayed at regular periods, the strengths are considerably decreased and vary greatly; thus French will stand 6 atmospheres; English, 7; Verbund-Robax, 15; Durax, 27; and Durobax, 31 atmospheres. The makers of Durobax seem to have improved on their resistance to attack by steam and feed-water, as their gauge-glasses remain clear for a long time.

Electric Furnace for Non-ferrous Metals. (*Mech. Eng.*, xxx, 125.)—This type of resistance furnace, or a combination of arc and resistance furnace, is the invention of R. S. Wile and has been developed by the Pittsburgh Electric Furnace Company. Four carbon electrodes are used, two through the bottom and two through the top. The specialty is that when preparing to make a heat the furnace is partially filled with broken glass, and the carbon electrodes are arranged so that an arc is formed which melts the glass. As the glass becomes molten it acts as a conductor, and when it is very fluid the electrodes are moved farther apart and the metal is charged into the furnace; this sinks to the bottom, and the fluid glass protects it from oxidation. The glass can be used for several months. In melting brass scrap the loss can be kept as low as 1⅓ per cent.

Permanent Fireproofing of Cotton Goods. W. H. PERKIN. (*Eighth International Cong. Appl. Chem.*)—A description is given of the series of experiments which led to the commercial production of permanently fireproofed flannelette. The first process worked on a commercial scale consisted in treating the material successively with sodium stannate and with a mixture of sodium tungstate, zinc acetate, and acetic acid. The treated material, however, tended to become damp, the fireproofing was not sufficiently permanent, and the cost of the process was too high. The process finally arrived at was this: the flannelette is impregnated with a solution of sodium stannate of about 45° Twaddell, squeezed, dried on heated copper drums, passed through a solution of ammonium sulphate of about 15° Tw. to precipitate the tin oxide, again squeezed and dried, washed to remove the sodium sulphate, dried, and finished as usual. The tin oxide is probably present in actual combination with the fibre, for the fireproofing is not destroyed by repeated washing with hot water and soap. The treated material can be dyed the most delicate shades, exerts no deleterious action on the skin, and is stated to be stronger and more durable than the untreated material. With tin at £210 per ton, the cost of the process is not more than 1d. per yard. The process is applicable to muslin, lace curtains, etc.

The Ageing and Preservation of Wood. M. DE KEYHEL. (*Rev. Gén. Chim.*, XV, 85.)—*Ageing.*—Old wood contains about 10 per cent. of water held mechanically in the pores of the wood, and this amount is independent of the relative humidity of the atmosphere. Green wood changes its size and shape on account of the water being absorbed by hygroscopic substances in the sap. Artificial ageing is produced by extracting these hygroscopic substances, by this method, viz.: the wood is immersed for 24 hours in a solution of 600 Kg. of 26° Be. tetra-isol, 250 Kg. ammonia, and 100,000 litres water. This solution is driven out by immersing the wood in Me_2CO and recovering the latter by heating in a retort. Wood can be given a very high electrical resistance by immersing it in a bath of linseed oil after the Me_2CO treatment and heating it to 70° C. *Preservation.*—A preservative must possess these characteristics: it must be in a sufficiently fluid solution to penetrate the whole of the wood, which is impossible with creosote; it must become insoluble after the solvent has evaporated, and must form a stable combination with the sap; it must not change the qualities of the tissues of the wood as regards elasticity, suppleness, and resistance to mechanical action, and must make the cellulose able to resist insects; it must be cheap and not dangerous to handle. Formulas are given for preservatives that have produced excellent results.

Specifications for the Oil for Mixing with Concrete. (*Bull. XLVI. Office of Public Roads, U. S. A.*)—These specifications are given for residual oils intended for waterproofing concrete according to L. W. Page's process. (1) The oil shall have a specific gravity of 0.930 to 0.940 at 25° C. (2) At least 99.9 per cent. shall be soluble in carbon bisulphide at the ordinary temperature. (3) It shall contain 1.5 to 2.5 per cent. of bitumen insoluble in paraffin naphtha of 86° Be. (4) It shall yield 2.5 to 4 per cent. of residual coke. (5) When 240 c.c. of the material are heated to 50° C. in an Engler viscosimeter and maintained at this temperature for at least 6 minutes, the first 100 c.c. which flow out shall show a viscosity of 40 to 45. (6) When 20 grammes of the material are heated to 163° C. for 5 hours in a cylindrical tin vessel, 2½ inches diameter by 1 inch high, the loss in weight shall not exceed 2 per cent.

Active Deposits from the Air in the Bolivian Andes. W. KNOCHE. (*Physik. Zeit.*, xiii, 440.)—The active deposits obtained on charged insulated wires at an elevation of 5200 metres proved remarkably radioactive. The surface rocks were relatively inactive. These active deposits consisted of radium, thorium, and probably actinium products, but the radium always predominated. Slight activities were also obtained on neutral and positively charged wires.

Fireproofing and Insulation of Wood. M. DE KEYHEL. (*Rev. Chim. Ind.*, xxiii, 152.)—This is a discussion of principles, methods, and materials, from which the conclusion is reached that impregnation under pressure is the most efficient method. As a general principle each species of wood requires a different pressure for the necessary penetration, but the pressure remains constant for the same species, regardless of the dimensions of the piece to be impregnated. The penetration of the wood by a crystalloidal liquid is a function of the time. When displacement and penetration take place in a longitudinal sense, irrespective of pressure, the rapidity or duration of the injection will always be in direct relation to the length; for a given length and constant pressure, for the same species, the rapidity may, in certain cases, vary with the initial capillary speed, depending on the concentration of the injected solution. The species generally used are oak, mahogany, teak, ash, beech, gum, walnut, poplar, fir, pitch pine, pine, and birch. The double phosphate of zinc and ammonia obtained by dissolving zinc hydroxide in ammonium hydroxide, and adding phosphoric acid, is superior to any other salt for impregnation, and is the only one that can be applied without inconvenience. The method of making it on a large scale is given.

Soldering Lead Pipes with Lead. ANON. (*Amer. Mach.*, xxxvii, 4, 151.)—The soldering of lead pipes with lead or "lead-burning" was known and practised in the Middle Ages. Vincent de Beauvais, who died in 1264, wrote: "If tin is exposed to a moist atmosphere, it will corrode; but human ingenuity has of late invented useful improvements by which it is possible to unite leaden subterranean water pipes with the aid of *molten lead* instead of soldering with tin. Pipes soldered with the latter metal never lasted long, but if lead is used it will last for all time."

The Preservation of Wood with "Bellit." NOWOTNY. (*Oesterr. Chem. Ztg.*, xv, 100.)—Sodium fluoride is mixed with nitro-phenols to increase its preservative effect. One of these compounds, known as "Bellit," consists of 90 parts of 90 to 95 per cent. sodium fluoride with 10 parts of dinitrophenolaniline. This latter is an active antiseptic and has no action on the iron vessels used for impregnating. The selective phenomena observed with mixtures of zinc fluoride and hydrochloric acid are also observed in the "Bellit" process.

Delta Rays. N. CAMPBELL. (*Phil. Mag.*, xxiii, 46.)—The speed of the δ-rays is independent of the speed of the α-rays which excite them, as well as of the material from which they emanate. The magnetic methods hitherto used to measure the speed of the δ-rays are considered somewhat untrustworthy.

The Absorption and Scattering of the Alpha Rays. C. G. DARWIN. (*Phil. Mag.*, xxiii, 901.)—Accepting the atomic structure proposed by Rutherford, a hypothesis is presented which assumes that the α particles in passing through matter draw electrons out of the atoms they traverse, acting on them according to the ordinary law of the inverse square, and losing their own velocity by thus imparting motion to a cluster of electrons. A velocity curve equation has been deduced connecting the velocity of the α particles with the distance they have traversed from their origin, which agrees closely with the curve found by experiment. It contains two unknown constants, n, the number of electrons in each atom, and σ the radius of the atom. Assuming the latter in the case of air, the former can be deduced from the range of the particles. Widely different values of σ give very similar values for n. From a computation of the retarding powers of air and other substances, σ and n can be deduced for these. The number of the electrons in the atom appears to be intermediate between the atomic weight and its half. The atomic radii decrease as the atomic weight increases. In the cases of hydrogen and helium the equation does not seem to apply. A similar formula is developed for scattering, and in all cases gives results which agree closely with the experimental observations.

Large Castings for the New White Star Liner. ANON. (*Eng.*, xciv, 2438, 391.)—The Darlington Forge Company have gained a world-wide reputation in producing castings of record dimensions. Difficulties have been experienced in conveying these castings from the forge to their destination, as these castings often extend over a double set of rails. Consequently they travel by rail on Sundays when the lines are clear. These conditions were arranged for them when the stern frame of the latest White Star liner was conveyed to West Hartlepool, where the large North-Eastern Railway cranes placed the castings on board for shipment to Belfast. This stern frame weighed nearly 80 tons, and was in two sections. It was a larger casting than the firm supplied for the *Titanic*.

Radioactivity of the Carlsbad Springs. W. KOLHÖRSTER. (*Ber. Physik. Ges.*, 1912, 356.)—Many investigators have shown that the Carlsbad spring waters contain dissolved radium salts. This radium can be separated nearly quantitatively by adding a few drops of barium chloride solution to the boiling water, which has been acidified by sulphuric acid. This simple method removes all but one per cent. of the radium in the water from the thermal spring, the radium content of which was found to be approximately 5.5×10^{11} grammes per litre. The iron hydroxide separated when the water is aërated does not remove the radium salts. A trace of thorium emanation was detected in the water.

A New Strong Brass Alloy Containing Silicon. ANON. (*Brass World*, viii, *II*, 390.)—This alloy is patented by Alfred Schmid in U. S. Patent 1,040,027, October 1, 1912. The best proportions are:

Copper	58 pounds
Zinc	40 pounds
Tin	1 pound
30 per cent. silicon copper	1 pound

which makes the true proportions:

Copper	58.70%
Zinc	40.00%
Tin	1.00%
Silicon	0.30%

Tensile strength, 68,000 to 78,000 pounds per square inch.
Elastic limit, 28,000 to 42,000 pounds per square inch.
Elongation, 25 per cent. to 35 per cent.

There are no shrink holes, and the alloy does not segregate. It is malleable when red hot, and may be rolled or forged.

The Pennsylvania Chestnut Tree Blight Commission has just issued for the information of the public Bulletin No. 1, giving the means of identifying the chestnut blight disease and suggesting remedies for its control and eradication.

The document points out the great danger of extermination that menaces Pennsylvania's vast chestnut resources, and urges a prompt and vigorous co-operation generally in the efforts to stamp out this new but terribly destructive pest of our native chestnut trees.

The disease has already entailed losses to timber owners in Pennsylvania amounting to fully ten millions of dollars, having been especially virulent in southeastern Pennsylvania, where thousands of trees were killed by the blight. West of the Allegheny Mountains, by a concentrated effort of the Commission and timber owners, the blight will practically be wiped out by the close of the year, thus giving the assurance that a large portion of Pennsylvania's many millions of dollars' worth of chestnut may be saved, and the disease checked before it can spread into the valuable timber of adjacent States.

The bulletin describes many phases of the blight, and the warfare that is being waged to control the outbreak. It defines very clearly that, contrary to the erroneous opinion advanced by one or two writers, the blight is of a parasitic form, and the trees are not killed by any insects, as has been stated. The fungus is spread, however, by the wind, animals, birds, insects, etc., and

when trees are infected it soon girdles the twigs, branches, and trunks, thus causing their death.

At this season of the year, when chestnut trees are found with branches bearing dry leaves and immature burrs, cankers, orange-colored pustules, etc., it is an indication that the tree is seriously diseased.

The bulletin also refers to the economic and profitable utilization of trees killed by the blight. The Commission acquired much valuable information upon the subject, and can therefore prove of genuine service to those seeking markets for commercial products of the chestnut.

Chestnut nursery stock can only be sold and shipped after it has been carefully inspected and properly tagged. A tree that does not appear to be entirely free from the disease is condemned and burned.

Copies of the bulletin are available and will be sent without charge upon request to the Commission, Morris Building, Philadelphia.

Chlorides in Feed-water. E. E. BASCH. (*Techn. Rundschau,* xvii, 561.)—The main source of corrosion in steam boilers is magnesium chloride. The boiler plate becomes overheated under the boiler scale, and the hydrochloric acid is set free and causes corrosion. Sodium chloride is considered harmless until it oversteps the saturating point, and so precipitation occurs. A mixture of lime and soda is successfully used to make magnesium chloride harmless. Caustic soda can be used also, but is more expensive. The only remedy for an excess of sodium chloride is its removal by distillation, which is too expensive.

The New Hydra Photographic Plate. O. MENTE. (*Atelier Phot.,* xix, 82.)—The gradation of the image is not between the deepest shadow and the highest light, as in ordinary plates, but between the deepest shadow and some one high light, as all higher lights have this same density and no solarization appears. Exposures not exceeding forty times normal may be developed with pyro-soda, but a special developer is recommended for exposures beyond this limit. The absence of halation is partly due to the thickness of the film and partly to a red backing, the color of which disappears in the fixing bath.

Explosion of Radium Bromide. B. JOST. (*Chem. Zeit.,* xxxvi, 138.)—Occasional explosions of specimens of radium bromide are attributed to the gradual absorption of moisture, which weakens the forces of cohesion in the crystal to the point where the pressure of the accumulated emanation (helium) suddenly ruptures the crystal.

The Original Source of Metalliferous Ores. G. W. MILLER. (*Mining Eng. World,* xxxvi, 515.)—The presence of igneous rocks, which is generally favorable to ore deposits at some place near by, may affect the development of ore deposits in various ways: (1) They may furnish metal for the ores; (2) or water and gaseous solutions which facilitate the transportation of the metals. (3) Their heat may render the solution vastly more active in segregating the ores from the parent igneous rocks. (4) Their introduction may promote fracturing and thus open channels for circulation. (5) Open channels may be formed by the cooling and consequent contraction. (6) They may furnish avenues in the way of long and deep-seated, impervious trunk channels of circulation. (7) They are often easily soluble and hence afford large avenues for the reception of ores through the processes of metasomatic replacement. The origin of ores is to be sought in the igneous rocks which they generally accompany. Through volcanism the molten rocks are brought to the upper zones of the lithosphere, where they are subjected to the leaching processes of the circulating underground waters, which extract their metals and transport and redeposit the soluble metals as ores in the variously-formed receptacles along the water passages. In some localities evidence points to the formation of ore deposits by magmatic segregation, deposits formed by fumaroles, by subterranean mineralized gases, etc., but the sum of these is considered insignificant in comparison with those deposits formed through the processes of circulating underground waters.

Plasticity of Clay. J. STEWART. (*Eighth Int. Cong. Appl. Chem. Sect. vii,* xv, 265.)—The suggestion is made that the plasticity of clay is due to the presence of an organic aluminum compound. This assumption is claimed to explain satisfactorily all the established facts concerning the plasticity of clay. For example, it explains why only impure clays are plastic; why ignition destroys and levigation fails to restore plasticity; the industrial practice of weathering clay before use, and why the plasticity is reduced by bases, since the aluminum organic compound is soluble in alkali.

Nickel-plating Electrogalvanized Articles. ANON. (*Brass World,* viii, II, 385.)—W. Feuerhake, of Westphalia, has patented a process for making iron or steel articles rust-proof and at the same time giving them a good finish. The iron or steel goods are first electrogalvanized, and then lightly copper-plated from a copper cyanide solution. Then nickel plate is deposited on the copper, which produces an excellent, rust-proof finish. The object of copper-plating is that, while nickel can be plated direct on zinc, it is unsatisfactory as a commercial proposition, and it is always advisable to copper the zinc first.

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